UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
7600 Sand Point Way N.E., Bldg. 1
BIN C15700
Seattle, WA 98115-0070

Refer to:
OSB2001-0154

April 26, 2002

Mr. Lawrence Evans
U.S. Army Corps of Engineers, Portland District
ATTN: Ms. Mary Headley
P.O. Box 2946
Portland, Oregon 97208-2946

Re: Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Act Essential Fish Habitat Consultation for the BAIC, Inc., Willow Creek Dredging Project, Columbia River at River Mile 252.8, Gilliam County, Oregon (Corps No.: 2000-01038)

Dear Mr. Evans:

Enclosed is a biological opinion (Opinion) prepared by the National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act (ESA) on the effects of the proposed BAIC, Inc., Willow Creek Dredging Project. In this opinion, NMFS concludes that the proposed action is not likely to jeopardize the continued existence of Snake River (SR) fall-run chinook salmon (*Oncorhynchus tshawytscha*), SR spring/summer-run chinook salmon, Upper Columbia River (UCR) spring-run chinook salmon, SR sockeye salmon (*O. nerka*), UCR steelhead (*O. mykiss*), Snake River Basin steelhead, and Middle Columbia River steelhead, or destroy or adversely modify designated critical habitat. As required by section 7 of the ESA, NMFS included reasonable and prudent measures with nondiscretionary terms and conditions that NMFS believes are necessary to minimize the impact of incidental take associated with this action.

This Opinion also serves as consultation on essential fish habitat pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations at 50 CFR Part 600.

If you have any questions regarding this consultation, please contact Marc Liverman of my staff in the Oregon State Branch Office at (503) 231-2336.

Sincerely,

For Michael R Crouse

D. Robert Lohn
Regional Administrator

Endangered Species Act - Section 7 Consultation
&
Magnuson-Stevens Act Essential Fish Habitat Consultation

BIOLOGICAL OPINION

BAIC, Inc.,
Willow Creek Dredging Project
Columbia River at River Mile 252.8
Gilliam County, Oregon

Agency: Army Corps of Engineers, Portland District

Consultation Conducted By: National Marine Fisheries Service, Northwest Region

Date Issued: April 26, 2002

Issed by: for Michael R Crouse
D. Robert Lohn
Regional Administrator

Refer to: OSB2001-0154-FEC

TABLE OF CONTENTS

1. INTRODUCTION

The U.S. Army Corps of Engineers (COE) proposes to issue a permit to BAIC, Inc. (BAIC) to maintenance dredge an existing channel next to two existing irrigation pump stations in the Willow Creek Arm of the Columbia River, at River Mile 252.8. The purpose of the proposed action is to provide an adequate flow of water for the pumps, to prevent sediment from fouling the pumps, and to keep the fish screen installed on the pumps compliant with NMFS surface area criteria. The applicant also proposes to monitor the movement patterns of listed salmonids within the Willow Creek Arm relative to pump station operations to ensure that proposed conservation measures are effective for minimizing take and to help resolve the relationship between pump station operations and the timing, distribution, and abundance of any ESA-listed fish and their predators in Willow Creek and Willow Creek Arm. The COE proposes to issue the permit pursuant to section 10 of the Rivers and Harbors Act of 1899.

The action area for this consultation is the part of the habitat of ESA-listed salmonids that is affected by the proposed Willow Creek dredging project. That area encompasses the Willow Creek Arm of the Columbia River down to and including the John Day Pool. The action area also extends upstream in Willow Creek to the farthest point at which ESA-listed salmonids or their habitats are influenced by Willow Creek dredging.

1.1 Consultation History

On August 11, 2000, the National Marine Fisheries Service (NMFS) received a letter dated August 10, 2000, from the COE[1] describing the start of a process to reevaluate operation of an existing, permitted irrigation pump station in Willow Creek near its confluence with the Columbia River. This followed a determination by the COE that operation of the pump station, under existing Federal permits, may affect threatened and endangered species or their critical habitat.[2] The COE also advised NMFS that it was assessing information received from the permittee regarding the biological effects of the on-going project based on its current and intended operational conditions. Further, the COE anticipated preparing a biological assessment to consider the effects of the current pumping practices on essential behaviors of ESA-listed salmon and any other considerations developed during the review, and initiating formal consultation in November 2000.

---

[1] Letter from Lawrence C. Evans, COE, to Michael Crouse, NMFS (August 10, 2000) requesting establishment of point of contact for pending consultation on irrigation plant in Willow Creek near confluence on Columbia River.

[2] See, Federal defendants' notice of filing of "may affect" determination by Corps of Engineers, WaterWatch v. U.S. Army Corps of Engineers, Civ. No. 99-861-BR (July 28, 2000).

On September 29, 2000, NMFS received a copy of a letter dated September 25, 2000, from David Evans and Associates (DEA) to the COE and Oregon Division of State Lands explaining that it was undertaking repairs of the Willow Creek pump station intended to comply with NMFS' fish screen criteria.[3]

In a letter dated October 17, 2000, the COE wrote to BAIC,[4] the permit holder and continuous user of the Willow Creek facility, confirming its status as "applicant" for the pending consultation. Consistent with sections 7(a)(3), (b) and (c) of the Endangered Species Act (ESA) and implementing regulations at 50 CFR 402, the COE, as the action agency, determined the role that BAIC may play during the consultation. In this letter, the COE advised BAIC that it had been helpful providing information necessary to complete consultation and that it would be allowed and expected to continue to do so. The COE also explained to the applicant that it could be subject to a duty under section 7(d) of the ESA not to make any irreversible or irretrievable commitment of resources with respect to the on-going irrigation operation that fall within the scope authorized by BAIC's permits until the COE and NMFS competed their consultation. Specifically, the COE requested that the applicant refrain from any activity that would foreclose the ability of the COE to act on the reevaluation of the BAIC permits in the public interest. On October 25, 2000, BAIC replied to the COE agreeing to cooperate as necessary to complete a timely consultation and describing commitments to meet the intent of section 7(d) until the consultation is complete.[5]

At the invitation of BAIC, NMFS staff briefly visited the Willow Creek pump station on October 24, 2000. Staff from BAIC and DEA were present and provided a guided tour of the site and facility, and an overview of site history, facility operation and maintenance. The first formal meeting to discuss the pending consultation between NMFS staff and representatives of BAIC took place in the Portland Office of NMFS on November 2, 2000. At that meeting, BAIC explained how the Willow Creek pumping operation is vital to the environmentally-progressive business plan for Threemile Canyon Farms, L.L.C. NMFS presented a draft consultation outline and described how issues related to the distribution and abundance of salmonid species in the Willow Creek Arm, dredging effects, fish screens, and pumping effects could be resolved. BAIC and NMFS staff have continued to meet as necessary to exchange consultation information[6] and have frequent telephone conversations for that purpose.

---

[3] Letter from Dana Siegfried, DEA, to Jim Anderson, COE, and Bob Brown, Oregon Division of State Lands (September 25, 2000) (BAIC Columbia River pump stations repair and maintenance activities).

[4] Letter from Lawrence Evans, COE, to Marty Myers, BAIC, Inc. (October 17, 2000) (confirming applicant status and requesting that BAIC refrain from interim or further action concerning ongoing irrigation actions will the scope of the underlying permits pending completion of consultation).

[5] Letter from Martin Myers, BAIC, Inc., to Lawrence Evans, COE (October 25, 2000) (activities during consultation on permit nos. 071-OYA-000484 and 071-OYA-20002537).

[6] Meetings between BAIC and NMFS staff occurred in NMFS' Portland Office on November 2, 2000, December 8, 2000, January 10, 2001, and February 12, 2001 (with participation by Bob Turner, COE), June 7, 2001, and March 20, 2002. BAIC also provided project briefings for NMFS managers from the Habitat Conservation Division and Northwest Region on December 8, 2000, February 6, 2001, April 4, 2001, and April 10, 2002.

On December 8, 2000, NMFS received a letter from Tom Lindley, an agent of BAIC, and Karen Russell, a representative of WaterWatch, a public interest environmental group.[7] That letter transmitted a copy of the settlement agreement resolving litigation over the Willow Creek pumping facility and, pursuant to the settlement agreement, requested that NMFS provide assurances that BAIC may continue to operate the facility at current levels pending completion of consultation on the effects of the pump station.

On January 8, 2001, NMFS received a letter from BAIC dated December 29, 2000[8] describing an inspection, repairs and monitoring of fish screens installed on the Willow Creek pump facility. Based on that information, BAIC requested that NMFS issue a 4(d) take limitation certifying that those screens are in compliance with NMFS' fish screen criteria.[9]

The COE issued a Public Notice for Permit Application to authorize the proposed project for 3-biannual dredging cycles on January 10, 2001.[10] The permit was proposed to be issued with these two conditions: a) All in-water work, including release of effluent from the dredged material disposal site, shall occur within the Oregon Department of Fish and Wildlife (ODFW) preferred work period, which is between December 1 and March 31 for the project area; and b) work in the waterway shall be performed in a manner to minimize turbidity.

Regarding ESA-listed species, the notice pointed out that a consultation with NMFS on the effects of the previous maintenance dredging project[11] concluded that the project would not likely adversely affect an endangered or threatened species or its critical habitat.

On January 17, 2001, NMFS received a letter from the COE dated January 5, 2001[12] initiating informal consultation for maintenance dredging portion of the proposed project and requested concurrence with its determination that the project may affect but is not likely to adversely affect ESA-listed species of Columbia River and Snake River salmon and steelhead. A biological

---

[7] Letter from Tom Lindley, Perkins Coie, and Karen Russell, WaterWatch, to Michael Tehan, NMFS (December 7, 2000) regarding operation of the Willow Creek pumping facility during consultation.

[8] Letter from Dana Siegfried, DEA, to Larry Swenson, NMFS (December 29, 2000) requesting 4(d) take limitation for fish screens installed at BAIC, Inc. pumping facility and transmitting DEA and Kevin L. Crew, P.E., Compliance evaluation of the BAIC, Inc. screened diversion with respect to NMFS Criteria, November 2000, 5 pages + exhibits.

[9] NMFS, Environmental & Technical Services Division, Juvenile fish screen criteria for pump intakes (May 9, 1996) http://www.nwr.noaa.gov/1hydrop/pumpcrit1.htm

[10] COE, Portland District, Public Notice of Permit Application by BAIC, Inc., (January 10, 2001) Corps of Engineers Action ID: 2000-01038.

[11] Letter from William Stelle, Jr., NMFS, to W.B. Paynter, COE (March 29, 1996) (concurring with the COE determination that maintenance dredging in the Willow Creek Arm of the John Day Reservoir was unlikely to adversely affect ESA-listed species).

[12] Letter from Lawrence C. Evans, COE, to Michael Crouse, NMFS (January 5, 2001)(initiating informal consultation on the BAIC, Inc., Willow Creek Dredging Project).

assessment[13] for the project was transmitted with the letter.

The COE advised BAIC on January 24, 2001 that it would soon complete a biological assessment for the consultation on operation of the Willow Creek pumping facility.[14] This letter also notified BAIC, that it may continue to use the pumping facility to divert up to, but not more than, 480 cfs at a peak rate of use.

NMFS agreed to complete consultation on the dredging portion of BAIC's Willow Creek operation before evaluating the effects of the pumping based on the following considerations: 1) Operation of the Willow Creek pump stations is the subject of COE authorizations that are separate from the dredging authorization, and that will be the subject of a separate and pending ESA consultation; 2) the COE and BAIC have both offered assurances that they will not make any irreversible or irretrievable commitment of resources with respect to the pumping facility until the COE and NMFS complete consultation on that part of the project; and 3) BAIC informally requested separate consultation on the dredging and pumping parts of their enterprise due to concerns that farm operations may be interrupted before completion of consultation unless the dredging portion of the project was completed first.

NMFS sent a letter to BAIC on January 26, 2001[15] explaining ESA requirements for the COE and BAIC pending completion of consultation. That letter also agreed with the COE finding that continued operation of the pump stations at a maximum rate of 480 cfs or less pending in the interim is not likely to be prohibited by the ESA, and noted that NMFS had not identified any additional conservation actions to avoid or minimize take that BAIC should undertake before completion of consultation.

On March 15, 2001, NMFS received an application from BAIC[16] for a scientific taking permit to monitor movement patterns of ESA-listed salmonids in Willow Creek relative to pump station operations. Data collected in this study are intended help the COE and NMFS determine the relationship between pump station operations and the timing, distribution, and abundance of any

[13] DEA and John Palmisano Biological Consultants, *Biological Assessment for the Willow Creek Dredging Project*, 23 pp. + appendices (November 2000). The following information has been received to supplement the *Biological Assessment:* HartCrowser, Inc., *Sediment Characterization Report Willow Creek Dredging Project, Boardman Oregon*, 4 pp + appendices (January 5, 2001)(prepared for DEA)(received by NMFS on February 23, 2001); Transmittal from Dana Siegfried, DEA, to Larry Swenson, NMFS (January 29, 2001)(July 1994 aerial photograph and 1995bathymetry base map with December 2000 bathymetry spot elevations)(received by NMFS January 31, 2001); Memorandum from Dana Siegfried, to Marc Liverman and Larry Swenson, NMFS (March 6, 2001)(information request)(received by NMFS March 8, 2001).

[14] Letter from Lawrence C. Evans, COE, to Marty Myers, BAIC, Inc. (January 24, 2001) (permits no. 071-OYA-000484 and 071-OYA-002537; ESA consultation).

[15] Letter from Michael Tehan, NMFS, to Tom Lindley, Perkins Coie, L.L.P. (January 26, 2001) agreeing with finding by COE that continued operation of the Willow Creek pump stations at the present maximum rate of 480 cfs or less is unlikely to foreclose NMFS' ability to conclude consultation on pumping operations with a reasonable and prudent alternative that is likely to avoid jeopardy or adverse modification of critical habitat.

[16] Transmittal from Dana Siegfied, DEA, to Marc Liverman, NMFS (March 15, 2001) application for scientific permit to study movement patterns of ESA-listed salmonids in Willow Creek.

salmonid species (emphasizing subyearling MCR steelhead) and their predators found in Willow Creek, and the Willow Creek Arm.

The 2001 water year proved to be a severe drought. On April 24, 2001, NMFS received a copy of a letter from BAIC[17] to the COE requesting an extension of this consultation and citing the need for further development of site-specific monitoring studies related to the Willow Creek facility. As a result, the proposed dredging operations and study of fish movements in Willow Creek Arm were both delayed one year. In the interim, NMFS and the applicant continued informal discussions about opportunities to minimize the adverse effects of the dredging operation, including return flows from the upland dredge spoil disposal area, and refine the proposed fish study.[18]

On March 14, 2002, the applicant submitted a revised monitoring plan to obtain information about attraction flows and fish use of the action area.[19]

1.2 Proposed Action

The proposed dredging consists of up to 4000 cubic yards of sand and silt on a biannual basis and additional unscheduled dredging that complies with standard permit conditions. Information in the biological assessment provided by the applicant states that sandy material accumulates within the Willow Creek Arm in the pump station forebay at an average rate of 2616 cubic yards per year to a depth of approximately three feet. The proposed dredge area is 1800 feet long by 24 feet wide, with an average depth of 2.5 feet. Dredging would occur using a barge-mounted 8-inch hydraulic dredge for about two weeks in February or March.

Dredged material would be disposed of next to the pump station in a settling basin created for that purpose. The settling basin is 300 feet long by 100 feet wide and equipped with baffles and a standpipe to slow velocities and ensure adequate settling before water is discharged into Willow Creek.

The applicant also proposes to monitor the movement patterns of ESA-listed salmonids within the Willow Creek Arm relative to pump station operations. The purpose of this monitoring is ensure that proposed conservation measures are effective for minimizing take from the proposed dredging and to help resolve the likelihood of take from pump station operations by determining relationships between the timing, distribution, and abundance of any ESA-listed species their

---

[17] Letter from Martin Myers, BAIC, Inc. to Lawrence Evans, COE (April 19, 2001) requesting extension of consultation on Willow Creek irrigation pumping facility.

[18] See, e.g., Memo from Dana Siegfried, DEA, to Marc Liverman, NMFS (May 9, 2001) discussing Willow Creek sediment analysis; Letter from Dana Siegfried, DEA, to Larry Swenson, NMFS (July 12, 2001) BAIC, Inc. - Willow Creek pump station screens; Transmittal from Dana Siegfried, DEA, to Marc Liverman, NMFS (July 24, 2001) Willow Creek hydrographic survey, flows, settling pond and silt curtain information; Memo from Marc Liverman, NMFS to Dana Siegfried (August 6, 2001) conservation measures for cutting head dredge operation; letter from Dana Siegfried, DEA, to Marc Liverman, NMFS (November 1, 2001) discussing silt curtain and settling basin issues.

[19] Letter from Dana Siegfried, DEA, to Marc Liverman, NMFS (March 14, 2002) transmitting fish study proposal for Willow Creek Arm prepared by Ellis Ecological Services.

predators in Willow Creek and Willow Creek Arm.

The applicant proposed the following conservation measures to minimize the possible adverse effects of dredging:

1) All work will take place within the ODFW preferred in-water work period when juvenile salmon are least likely to be in the project vicinity.

2) The in-water work area, pump station, and outfall for the dredge spoil return flow will be enclosed in a silt curtain sufficient to isolate and contain any sediment suspended by dredge operations and the return flow.

3) The applicant will operate some of the irrigation pumps during dredging and dredge spoil dewatering to draw any suspended sediments into the pumps rather than allow them to disperse through the water to the Columbia River.

4) Dredged material will be allowed to settle temporarily in an upland settling area where a system of baffles and a stand pipe will assist in settling the particles. The return water will flow back to Willow Creek Arm into the silt fence containment area through a conveyance system that is adequately stabilized to prevent erosion. Dewatered dredged materials will be removed to a remote upland location for final disposition.

5) Part of the area previously permitted and used for dredge disposal will be restored to its pre-disposal elevation to compensate for fill of approximately 0.7 acres of area below the maximum Pool elevation of John Day Reservoir.

6) All fish monitoring will be completed according to established fish handling protocols designed to ensure this process will be minimally intrusive and of short-duration for ESA-listed species.

2. ENDANGERED SPECIES ACT

The Endangered Species Act (ESA) (16 USC 1531-1544), amended in 1988, establishes a national program for the conservation of threatened and endangered species of fish, wildlife, and plants and the habitat on which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with USFWS and NMFS, as appropriate, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or to adversely modify or destroy their designated critical habitats. This biological opinion (Opinion) is the product of an interagency consultation pursuant to Section 7(a)(2) of the ESA and implementing regulations found at 50 CFR Part 402.

2.1 Biological Opinion

The objective of this consultation is to determine whether the proposed Willow Creek dredging project is likely to jeopardize the continued existence of the following seven ESA-listed species of Columbia Basin salmonids, or causes the destruction or adverse modification of designated critical habitat.

- Snake River (SR) fall-run chinook salmon (*Oncorhynchus tshawytscha*) listed as threatened on April 22,1992 (57 FR 14653); critical habitat designated on December 28, 1993 (58 FR 68543); protective regulations were issued on July 10, 2000 (65 FR 4421)

- SR spring/summer-run chinook salmon (*O. tshawytsch*a) listed as threatened on April 22, 1992 (57 FR 14653); critical habitat designated on December 28,1993 (58 FR 68543) and revised on October 25, 1999 (64 FR 57399); protective regulations were issued on July 10, 2000 (65 FR 4421)

- Upper Columbia River (UCR) spring-run chinook salmon (*O. tshawytscha*) listed as endangered on March 24, 1999 (64 FR 14308); critical habitat designated on February 16, 2000 (65 FR 7764); ESA section 9 take prohibitions apply

- SR sockeye salmon (*O. nerka*) listed as endangered on November 20, 1991 (56 FR 58619); critical habitat designated on December 28, 1993 (58 FR 68543); ESA section 9 take prohibitions apply
- UCR steelhead (*O. mykiss*) listed as endangered on August 18,1997 (62 FR 43937); critical habitat designated on February 16, 2000 (65 FR 7764); ESA section 9 take prohibitions apply

- Snake River Basin (SRB) steelhead (*O. mykiss*) listed as threatened on August 18, 1997 (62 FR 43937); critical habitat designated on February 16, 2000 (65 FR 7764); protective regulations were issued on July 10, 2000 (65 FR 4421)

- Middle Columbia River (MCR) steelhead (*O. mykiss*) listed as threatened on March 25,1999 (64 FR 14517); critical habitat designated on February 16, 2000 (65 FR 7764); protective regulations were issued on July 10, 2000 (65 FR 4421)

2.1.1 Biological Information and Critical Habitat

Each of the seven species considered in this Opinion migrates through the John Day Pool portion of the action area. However, only SR fall-run chinook salmon and MCR steelhead are expected use the Willow Creek Arm as juvenile migration and rearing habitat, and only adult MCR steelhead are believed to migrate through Willow Creek Arm during some years to enter Willow Creek for spawning. Biological requirements during these life history stages are obtained through access to essential features of critical habitat. Essential features include adequate: 1) Substrate (especially spawning gravel), 2) water quality, 3) water quantity, 4) water temperature, 5) water velocity, 6) cover/shelter, 7) food, 8) riparian vegetation, 9) space, and 10) migration conditions [58 FR 68546 (December 28, 1993) for Snake River salmon and 65 FR 7764 (February 16, 2000)] for all other Columbia River Basin salmonids).

For purposes of this consultation, the relevant critical habitat types are: 1) Juvenile rearing areas, 2) juvenile migration corridors, and 3) adult migration corridors. The essential features of critical habitat for juvenile rearing and migration areas include adequate water quality, water quantity, water velocity, cover/shelter, food, riparian vegetation, space, and migration conditions. Essential features of adult migration corridors include all the essential features of critical habitat for juvenile rearing areas, with the exception of adequate food.

2.1.2 Evaluating the Proposed Action

The standards for determining jeopardy are set forth in section 7(a)(2) of the ESA as defined by 50 CFR Part 402 (the consultation regulations). In conducting analyses of habitat-altering actions under section 7 of the ESA, NMFS uses the following steps: (1) Consider the status and biological requirements of the species; (2) evaluate the relevance of the environmental baseline in the action area to the species' current status; (3) determine the effects of the proposed or continuing action on the species; (4) consider cumulative effects; and (5) determine whether the proposed action, in light of the above factors, is likely to appreciably reduce the likelihood of species survival in the wild or adversely modify its critical habitat. In completing this step of the analysis, NMFS determines whether the action under consultation, together with all cumulative effects when added to the environmental baseline, is likely to jeopardize the continued existence of the ESA-listed species or result in destruction, adversely modify their critical habitat, or both. If NMFS finds that the action is likely to jeopardize the ESA-listed species, NMFS must identify reasonable and prudent alternatives for the action.

Step 5 of this analysis ultimately requires that NMFS determine whether the species-level biological requirements can be met considering the significance of the effects of the action under consultation. Recovery planning can provide the best guidance for making this determination. The 1995 FCRPS biological opinion stated:

> Recovery plans for listed salmon call for measures in each life stage that are based upon the best available scientific information concerning the listed species' biological requirements for survival and recovery. As the statutory goal of the recovery plan is for the species' conservation and survival it necessarily must add these life-stage specific measures together to result in the survival of the species, at least, and its recovery and delisting at most. For this reason, the Recovery Plan is the best source for measures and requirements necessary in each life stage to meet the biological requirements of the species across its life cycle (p.14).

Recovery planning will identify the feasible measures that are needed in each stage of the salmonid life cycle for conservation and survival within a reasonable time. Measures are feasible if they are expected both to be implemented and to result in the required biological benefit. A time period for recovery is reasonable depending on the time requirements for implementation of the measures and the confidence in the survival of the species while the plan is implemented. The plan must demonstrate the feasibility of its measures, the reasonableness of its time requirements, and how the elements are likely to achieve the conservation and survival of the listed species based on the best science available.

In 1995, NMFS relied on the proposed Snake River salmon recovery plan, issued in draft in March 1995. Since 1995, the number of ESA-listed salmonid species and the need for recovery planning for Columbia Basin salmonids has quadrupled. Rather than finalize the 1995 proposed recovery plan, NMFS has developed guidelines for basin-level, multispecies recovery planning on which individual, species-specific recovery plans can be founded. "Basin-level" encompasses habitat, harvest, hatcheries, and hydro. This recovery planning analysis is contained in the document entitled "Conservation of Columbia Basin Fish: Final Basinwide Salmon Recovery Strategy" (hereafter, the Basinwide Recovery Strategy [Federal Caucus 2000]). The Basinwide Recovery Strategy replaces the 1995 proposed recovery plan for Snake River stocks until a specific plan for those stocks is developed on the basis of the Basinwide Recovery Strategy. Recovery plans for each individually listed species will provide the particular statutorily required elements of recovery goals, criteria, management actions, and time estimates that are not developed in the Basinwide Recovery Strategy.

Among other things, the Basinwide Recovery Strategy calls for restoration of degraded habitats on a priority basis to produce significant measurable benefits for listed anadromous and resident fish. Immediate and long-term priorities for restoration measures relevant to this consultation include the following general habitat improvements for mainstem reaches:

- Excavate backwater sloughs, silted-in lateral channels, restore or create alcoves and side channels and create islands and shallow-water areas, to provide habitat adjacent to the main channels suitable for spawning, incubation, rearing, resting and predator cover.
- Reestablish and enhance historic and existing wetlands.
- Plant riparian and aquatic plants at appropriate locations.
- Add large woody debris to increase organic material and enhance smolt habitat conditions by increasing pools and riffles, escape cover, sediment sinks, and a nutrient sources for macroinvertebrates.
- Address non-point pollution from agricultural and urban runoff, improve animal management in shoreline areas, reduce pesticide and fertilizer use and improve stormwater treatment.
- Develop and implement a monitoring and evaluation program.
- Use information from sampling reaches to develop plans for other reaches.

The Basinwide Recovery Strategy also established these specific habitat improvement action priorities for the mainstem of the Columbia River between Chief Joseph Dam and Bonneville Dam, the reach that includes Willow Creek and the Willow Creek Arm:

- Add large woody debris; create shallow water areas; enhance alcove, slough and side channel connections to the main channel; establish emergent aquatic plants in shallow water areas; and stabilize reservoir water levels.
- Restore habitat; acquire riparian corridors; modify flow regimes; reduce non-point pollution; and develop improvement plans for all reaches.

Until the species-specific recovery plans are developed, the Basinwide Recovery Strategy provides the best guidance for judging the significance of an individual action relative to the species-level biological requirements. In the absence of completed recovery planning, NMFS strives to ascribe the appropriate significance to actions to the extent available information allows. Where information is not available on the recovery needs of the species, either through recovery planning or otherwise, NMFS applies a conservative substitute that is likely to exceed what would be expected of an action if information were available.

2.1.2.1 Biological Requirements

The first step in the methods NMFS uses for applying the ESA to listed species is to define the biological requirements of the species most relevant to each consultation. NMFS also considers the current status of the listed species taking into account population size, trends, distribution and genetic diversity. To assess the current status of the listed species, NMFS starts with the determinations made in its decision to list the species for ESA protection and also considers new data available that are relevant to the determination.

The relevant biological requirements are those necessary for the listed species to survive and recover to naturally-reproducing population levels at which protection under the ESA would become unnecessary. Adequate population levels must safeguard the genetic diversity of the listed stocks, enhance their capacity to adapt to various environmental conditions, and allow them to become self-sustaining in the natural environment.

The biological requirements that are relevant to this consultation are adequate water quality, increased migration and spawning survival and improved habitat characteristics (including food availability and quality, and substrate composition) that function to support successful migration and rearing. The current status of the affected listed species, based upon their risk of extinction, has not significantly improved since these species were listed and, in some cases, their status may have worsened due to continuing downward trends toward extinction.

NMFS published the information in this section previously as Appendix A to the paper "A Standardized Quantitative Analysis of the Risks Faced by Salmonids in the Columbia River Basin" (McClure et al. 2000a). Additional details regarding the life histories, factors for decline, and current range wide status of these species are found in NMFS 2000a.

NMFS has adopted the species-level biological requirements as its jeopardy standard for the seven listed species being considered in this Opinion. The current status of these species, based on their risk of extinction, shows that their biological requirements are not being met. NMFS is not aware of any new data that would indicate otherwise. Nor is NMFS aware of any new data that would indicate their status has significantly improved since the species were listed. Improvements in survival rates (assessed over the entire life cycle) are necessary to meet species-level biological requirements in the future.

<u>Snake River Fall-run Chinook Salmon</u>. The Snake River basin drains an area of approximately 280,000 km^2 and incorporates a range of vegetative life zones, climatic regions, and geological formations, including the deepest canyon (Hells Canyon) in North America. The ESU includes the mainstem river and all tributaries, from their confluence with the Columbia River to the Hells Canyon complex. Because genetic analyses indicate that fall-run chinook salmon in the Snake River are distinct from the spring/summer-run in the Snake basin (Waples et al. 1991), SR fall-run chinook salmon are considered separately from the other two forms. They are also considered separately from those assigned to the UCR Summer- and fall-run ESU because of considerable differences in habitat characteristics and adult ocean distribution and less definitive, but still significant, genetic differences. There is, however, some concern that recent introgression from Columbia River hatchery strays is causing the Snake River population to lose the qualities that made it distinct for ESA purposes.

SR fall-run chinook salmon remained stable at high levels of abundance through the first part of the twentieth century, but then declined substantially. Although the historical abundance of fall-run chinook salmon in the Snake River is difficult to estimate, adult returns appear to have declined by three orders of magnitude since the 1940s, and perhaps by another order of magnitude from pristine levels. Irving and Bjornn (1981) estimated that the mean number of fall-run chinook salmon returning to the Snake River declined from 72,000 during the period 1938 to 1949 to 29,000 during the 1950s. Further declines occurred upon completion of the Hells Canyon complex, which blocked access to primary production areas in the late 1950s (see below).

Fall chinook salmon in this ESU are ocean-type. Adults return to the Snake River at ages 2 through 5, with age 4 most common at spawning (Chapman et al. 1991). Spawning, which takes place in late fall, occurs in the mainstem and in the lower parts of major tributaries (NWPPC 1989; Bugert et al. 1990). Juvenile fall-run chinook salmon move seaward slowly as subyearlings, typically within several weeks of emergence (Chapman et al. 1991). Based on modeling by the Chinook Technical Committee, the Pacific Salmon Commission estimates that a significant proportion of the SR fall-run chinook (about 36 percent) are taken in Alaska and Canada, indicating a far- ranging ocean distribution. In recent years, only 19 percent were caught off Washington, Oregon, and California, with the balance (45 percent) taken in the Columbia River (Simmons 2000).

With hydrosystem development, the most productive areas of the Snake River basin are now inaccessible or inundated. The upper reaches of the mainstem Snake River were the primary areas used by fall-run chinook salmon, with only limited spawning activity reported downstream from river kilometer (Rkm) 439. The construction of Brownlee Dam (1958; Rkm 459), Oxbow Dam (1961; Rkm 439), and Hells Canyon Dam (1967; Rkm 397) eliminated the primary production areas of SR fall-run chinook salmon. There are now 12 dams on the mainstem Snake River, and they have substantially reduced the distribution and abundance of fall-run chinook salmon (Irving and Bjornn 1981).

The Snake River has contained hatchery-reared fall-run chinook salmon since 1981 (Busack 1991). The hatchery contribution to Snake River escapement has been estimated at greater than 47 percent (Myers et al. 1998). Artificial propagation is recent, so cumulative genetic changes associated with it may be limited. Wild fish are incorporated into the brood stock each year, which should reduce divergence from the wild population. Release of subyearling fish may also help minimize the differences in mortality patterns between hatchery and wild populations that can lead to genetic change (Waples 1999). (See NMFS [1999a] for further discussion of the SR fall-run chinook salmon supplementation program.)

Some SR fall-run chinook historically migrated over 1,500 km from the ocean. Although the Snake River population is now restricted to habitat in the lower river, genes associated with the lengthier migration may still reside in the population. Because longer freshwater migrations in chinook salmon tend to be associated with more-extensive oceanic migrations (Healey 1983), maintaining populations occupying habitat that is well inland may be important in continuing diversity in the marine ecosystem as well.

For the SR fall-run chinook salmon ESU as a whole, NMFS estimates that the median population growth rate (lambda) over the base period[20] ranges from 0.94 to 0.86, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000b).

Snake River Spring/Summer-run Chinook Salmon. The location, geology, and climate of the Snake River region create a unique aquatic ecosystem for chinook salmon. Spring- and/or summer-run chinook salmon are found in several subbasins of the Snake River (CBFWA 1990). Of these, the Grande Ronde and Salmon rivers are large, complex systems composed of several smaller tributaries that are further composed of many small streams. In contrast, the Tucannon and Imnaha rivers are small systems with most salmon production in the main river. In addition to these major subbasins, three small streams (Asotin, Granite, and Sheep creeks) that enter the Snake River between Lower Granite and Hells Canyon dams provide small spawning and rearing areas (CBFWA 1990). Although there are some indications that multiple ESUs may exist within the Snake River basin, the available data do not clearly demonstrate their existence or define their boundaries. Because of compelling genetic and life-history evidence that fall-run chinook salmon are distinct from other chinook salmon in the Snake River, however, they are considered a separate ESU.

Historically, spring and/or summer chinook salmon spawned in virtually all accessible and suitable habitat in the Snake River system (Evermann 1895; Fulton 1968). During the late 1800s, the Snake River produced a substantial fraction of all Columbia River basin spring and summer chinook salmon, with total production probably exceeding 1.5 million in some years. By the mid-1900s, the abundance of adult spring and summer chinook salmon had greatly declined. Fulton (1968) estimated that an average of 125,000 adults per year entered the Snake River tributaries from 1950 through 1960. As evidenced by adult counts at dams, however, spring and summer chinook salmon have declined considerably since the 1960s (COE 1989).

In the Snake River, spring and summer chinook share key life history traits. Both are stream-type fish, with juveniles that migrate swiftly to sea as yearling smolts. Depending primarily on location within the basin (and not on run type), adults tend to return after either 2 or 3 years in the ocean. Both spawn and rear in small, high-elevation streams (Chapman et al. 1991), although where the two forms coexist, spring-run chinook spawn earlier and at higher elevations than summer-run chinook.

Even before mainstem dams were built, habitat was lost or severely damaged in small tributaries by construction and operation of irrigation dams and diversions, inundation of spawning areas by impoundments, and siltation and pollution from sewage, farming, logging, and mining (Fulton 1968). Recently, the construction of hydroelectric and water storage dams without adequate provision for adult and juvenile passage in the upper Snake River has kept fish from all spawning areas upstream of Hells Canyon Dam.

There is a long history of human efforts to enhance production of chinook salmon in the Snake

---

[20] Estimates of median population growth rate, risk of extinction, and the likelihood of meeting recovery goals presented here and below are based on population trends observed during a base period beginning in 1980. Population trends are projected under the assumption that all conditions will stay the same into the future. For further information, see, NMFS (2000).

River basin through supplementation and stock transfers. The evidence is mixed as to whether these efforts have altered the genetic makeup of indigenous populations. Straying rates appear to be very low.

For the SR spring/summer-run chinook salmon ESU as a whole, NMFS estimates that the median population growth rate (lambda) over the base period 1 ranges from 0.96 to 0.80, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to the effectiveness of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000b).

Upper Columbia River Spring-run Chinook Salmon. This ESU includes spring-run chinook populations found in Columbia River tributaries between the Rock Island and Chief Joseph dams, notably the Wenatchee, Entiat, and Methow River Basins. The populations are genetically and ecologically separate from the summer- and fall-run populations in the lower parts of many of the same river systems (Myers et al. 1998). Although fish in this ESU are genetically similar to spring chinook in adjacent ESUs (i.e., mid-Columbia and Snake), they are distinguished by ecological differences in spawning and rearing habitat preferences. For example, spring-run chinook in upper Columbia River tributaries spawn at lower elevations (500 to 1,000 m) than in the Snake and John Day River systems.

The upper Columbia River populations were intermixed during the Grand Coulee Fish Maintenance Project (1939 through 1943), resulting in loss of genetic diversity between populations in the ESU. Homogenization remains an important feature of the ESU. Fish abundance has trended downward both recently and over the long term. At least six former populations from this ESU are now extinct, and nearly all extant populations have fewer than 100 wild spawners.

UCR spring-run chinook are considered stream-type fish, with smolts migrating as yearlings. Most stream-type fish mature at 4 years of age. Few coded-wire tags are recovered in ocean fisheries, suggesting that the fish move quickly out of the north central Pacific and do not migrate along the coast.

Spawning and rearing habitat in the Columbia River and its tributaries upstream of the Yakima River includes dry areas where conditions are less conducive to steelhead survival than in many other parts of the Columbia basin (Mullan et al. 1992a). Salmon in this ESU must pass up to nine Federal and private dams, and Chief Joseph Dam prevents access to historical spawning grounds farther upstream. Degradation of remaining spawning and rearing habitat continues to be a major concern associated with urbanization, irrigation projects, and livestock grazing along riparian corridors. Overall harvest rates are low for this ESU, currently less than 10 percent (ODFW and WDFW 1995).

Spring-run chinook salmon from the Carson National Fish Hatchery (a large composite, non-native stock) were introduced into and have been released from local hatcheries (Leavenworth, Entiat, and Winthrop National Fish Hatcheries [NFH]). Little evidence suggests that these hatchery fish stray into wild areas or hybridize with naturally spawning populations. In addition to these national production hatcheries, two supplementation hatcheries are operated by the WDFW in this ESU. The Methow Fish Hatchery Complex (operations began in 1992) and the Rock Island Fish Hatchery Complex (operations began in 1989) were both designed to implement supplementation programs for naturally spawning populations on the Methow and Wenatchee rivers, respectively (Chapman et al. 1995).

For the UCR spring-run chinook salmon ESU as a whole, NMFS estimates that the median population growth rate (lambda) over the base period ranges from 0.85 to 0.83, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000b).

Snake River Sockeye Salmon. The only remaining sockeye in the Snake River system are found in Redfish Lake, on the Salmon River. The nonanadromous form (kokanee), found in Redfish Lake and elsewhere in the Snake River basin, is included in the ESU. SR sockeye were historically abundant in several lake systems of Idaho and Oregon. However, all populations have been extirpated in the past century, except fish returning to Redfish Lake.

In general, juvenile sockeye salmon rear in the lake environment for 1, 2, or 3 years before migrating to sea. Adults typically return to the natal lake system to spawn after spending 1, 2, 3, or 4 years in the ocean (Gustafson et al. 1997).

In 1910, impassable Sunbeam Dam was constructed 20 miles downstream of Redfish Lake. Although several fish ladders and a diversion tunnel were installed during subsequent decades, it is unclear whether enough fish passed above the dam to sustain the run. The dam was partly removed in 1934, after which Redfish Lake runs partially rebounded. Evidence is mixed as to whether the restored runs constitute anadromous forms that managed to persist during the dam years, nonanadromous forms that became migratory, or fish that strayed in from outside the ESU.

NMFS proposed an interim recovery level of 2,000 adult SR sockeye salmon in Redfish Lake and two other lakes in the Snake River basin (Table 1.3-1 in NMFS 1995b). Low numbers of adult SR sockeye salmon preclude a CRI- or QAR-type quantitative analysis of the status of this ESU. Because only 16 wild and 264 hatchery-produced adult sockeye returned to the Stanley basin between 1990 and 2000, however, NMFS considers the status of this ESU to be dire under any criteria. Clearly the risk of extinction is very high.

Upper Columbia River Steelhead. This ESU occupies the Columbia River basin upstream of the Yakima River. Rivers in the area primarily drain the east slope of the northern Cascade Mountains and include the Wenatchee, Entiat, Methow, and Okanogan River basins. The climate of the area reaches temperature and precipitation extremes; most precipitation falls as mountain snow (Mullan et al. 1992b). The river valleys are deeply dissected and maintain low gradients, except for the extreme headwaters (Franklin and Dyrness 1973).

Estimates of historical (pre-1960s) abundance specific to this ESU are available from fish counts at dams. Counts at Rock Island Dam from 1933 to 1959 averaged 2,600 to 3,700, suggesting a prefishery run size exceeding 5,000 adults for tributaries above Rock Island Dam (Chapman et al. 1994). Runs may, however, already have been depressed by lower Columbia River fisheries.

As in other inland ESUs (the Snake and mid-Columbia River basins), steelhead in the UCR ESU remain in freshwater up to a year before spawning. Smolt age is dominated by 2-year-olds.

Based on limited data, steelhead from the Wenatchee and Entiat rivers return to freshwater after 1 year in salt water, whereas Methow River steelhead are primarily age-2-ocean (Howell et al. 1985). Life history characteristics for UCR steelhead are similar to those of other inland steelhead ESUs; however, some of the oldest smolt ages for steelhead, up to 7 years, are reported from this ESU. The relationship between anadromous and nonanadromous forms in the geographic area is unclear.

The Chief Joseph and Grand Coulee dam construction caused blockages of substantial habitat, as did that of smaller dams on tributary rivers. Habitat issues for this ESU relate mostly to irrigation diversions and hydroelectric dams, as well as to degraded riparian and instream habitat from urbanization and livestock grazing.

Hatchery fish are widespread and escape to spawn naturally throughout the region. Spawning escapement is dominated by hatchery-produced fish.

For the UCR steelhead ESU as a whole, NMFS estimates that the median population growth rate (lambda) over the base period ranges from 0.94 to 0.66, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000b).

Snake River Basin Steelhead. Steelhead spawning habitat in the Snake River is distinctive in having large areas of open, low-relief streams at high elevations. In many Snake River tributaries, spawning occurs at a higher elevation (up to 2,000 m) than for steelhead in any other geographic region. SRB steelhead also migrate farther from the ocean (up to 1,500 km) than most.

No estimates of historical (pre-1960s) abundance specific to this ESU are available.

Fish in this ESU are summer steelhead. They enter freshwater from June to October and spawn during the following March to May. Two groups are identified, based on migration timing, ocean-age, and adult size. A-run steelhead, thought to be predominately age-1-ocean, enter freshwater during June through August. B-run steelhead, thought to be age-2-ocean, enter freshwater during August through October. B-run steelhead typically are 75 to 100 mm longer at the same age. Both groups usually smolt as 2- or 3-year-olds (Whitt 1954, Hassemer 1992). All steelhead are iteroparous, capable of spawning more than once before death.

Hydrosystem projects create substantial habitat blockages in this ESU; the major ones are the Hells Canyon dam complex (mainstem Snake River) and Dworshak dam (North Fork Clearwater River). Minor blockages are common throughout the region. Steelhead spawning areas have been degraded by overgrazing, as well as by historical gold dredging and sedimentation due to poor land management. Habitat in the Snake basin is warmer and drier and often more eroded than elsewhere in the Columbia River basin or in coastal areas.

Hatchery fish are widespread and stray to spawn naturally throughout the region. In the 1990s, an average of 86 percent of adult steelhead passing Lower Granite Dam were of hatchery origin. Hatchery contribution to naturally spawning populations varies, however, across the region.

Hatchery fish dominate some stocks, but do not contribute to others.

For the SRB steelhead ESU as a whole, NMFS estimates that the median population growth rate (lambda) over the base period ranges from 0.91 to 0.70, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000b).

Middle Columbia River Steelhead. The MCR steelhead ESU occupies the Columbia River basin from above the Wind River in Washington and the Hood River in Oregon and continues upstream to include the Yakima River, Washington. The region includes some of the driest areas of the Pacific Northwest, generally receiving less than 40 cm of precipitation annually (Jackson 1993). Summer steelhead are widespread throughout the ESU; winter steelhead occur in Mosier, Chenowith, Mill, and Fifteenmile creeks, Oregon, and in the Klickitat and White Salmon rivers, Washington. The John Day River probably represents the largest native, natural spawning stock of steelhead in the region.

Estimates of historical (pre-1960s) abundance specific to this ESU are available for the Yakima River, which has an estimated run size of 100,000 (WDF et al. 1993). Assuming comparable run sizes for other drainage areas in this ESU, the total historical run size may have exceeded 300,000 steelhead.

Most fish in this ESU smolt at 2 years and spend 1 to 2 years in salt water before reentering freshwater, where they may remain up to a year before spawning (Howell et al. 1985, BPA 1992). All steelhead upstream of The Dalles Dam are summer-run (Schreck et al. 1986, Reisenbichler et al. 1992, Chapman et al. 1994). The Klickitat River, however, produces both summer and winter steelhead, and age-2-ocean steelhead dominate the summer steelhead, whereas most other rivers in the region produce about equal numbers of both age-1- and 2-ocean fish. A nonanadromous form co-occurs with the anadromous form in this ESU; information suggests that the two forms may not be isolated reproductively, except where barriers are involved.

The only substantial habitat blockage now present in this ESU is at Pelton Dam on the Deschutes River, but minor blockages occur throughout the region. Water withdrawals and overgrazing have seriously reduced summer flows in the principal summer steelhead spawning and rearing tributaries of the Deschutes River. This is significant because high summer and low winter temperatures are limiting factors for salmonids in many streams in this region (Bottom et al. 1985).

Continued increases in the proportion of stray steelhead in the Deschutes River basin is a major concern. The ODFW and the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO) estimate that 60 percent to 80 percent of the naturally spawning population consists of strays, which greatly outnumber naturally produced fish. Although the reproductive success of stray fish has not been evaluated, their numbers are so high that major genetic and ecological effects on natural populations are possible (Busby et al. 1999). The negative effects of any interbreeding between stray and native steelhead will be exacerbated if the stray steelhead originated in geographically distant river basins, especially if the river basins are in different ESUs. The populations of steelhead in the Deschutes River basin include the following:

- Steelhead native to the Deschutes River
- Hatchery steelhead from the Round Butte Hatchery on the Deschutes River
- Wild steelhead strays from other rivers in the Columbia River basin
- Hatchery steelhead strays from other Columbia River basin streams

Regarding the latter, CTWSRO reports preliminary findings from a tagging study by T. Bjornn and M. Jepson (University of Idaho) and NMFS suggesting that a large fraction of the steelhead passing through Columbia River dams (e.g., John Day and Lower Granite dams) have entered the Deschutes River and then returned to the mainstem Columbia River. A key unresolved question about the large number of strays in the Deschutes basin is how many stray fish remain in the basin and spawn naturally.

For the MCR steelhead ESU as a whole, NMFS estimates that the median population growth rate (lambda) over the base period10 ranges from 0.88 to 0.75, decreasing as the effectiveness of hatchery fish spawning in the wild increases compared to that of fish of wild origin (Tables B-2a and B-2b in McClure et al. 2000b).

2.1.2.2 Environmental Baseline

Regulations implementing section 7 of the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area. The environmental baseline also includes the anticipated impacts of all proposed Federal projects in the action area that have undergone section 7 consultation, and the impacts of State and private actions that are contemporaneous with the consultation in progress. The action area is defined in 50 CFR 402.02 to mean "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action."

For the purposes of this consultation, the action area is the part of the habitat of listed salmonids that is affected by the proposed Willow Creek dredging project. That area encompasses the Willow Creek Arm of the Columbia River down to and including the John Day Pool. The action area may also extend upstream or downstream, based on the potential of the dredging project to impair fish passage or ecological processes related to the formation and maintenance of salmon habitats. Indirect effects may occur throughout the watershed where other activities depend on actions described in this Opinion for their justification or usefulness. These may include the effects of operating the Willow Creek pump stations to withdraw water for irrigation. However, as noted in Section 1.1 above, the effects of pumping will be evaluated in a subsequent consultation.

The Willow Creek Arm is an inlet from the John Day Pool that fills what appears to have once been a fully graded and meandering portion of the Willow Creek valley. The arm is approximately 7,000 feet long from the head of open water to the John Day Pool outlet, and varies in width from about 1,500 to 2,000 feet. Although the natural mouth of the Willow Creek valley was approximately 2,000 feet wide, the mouth of the Willow Creek Arm is constricted to a 200-foot opening where it passes under grades for a railroad and Highway 30. The Willow Creek pump station is near the southern end of the arm on the east side of a 600-foot delta formed where Willow Creek discharges into the arm. The proposed dredge prism extends north from the pump station, parallel to the Willow Creek delta and slightly beyond it. Available bathymetry shows that southern end of the arm has gently sloping banks and varies in depth to about 10 feet or less. The northern half has steeply sloping banks and reaches depths up to 30 feet. The Willow Creek valley to the south of the arm appears to follow the same grade for another 8,000 feet or so before narrowing into a gorge. This section of the valley is entirely filled with alluvial deposits.

In general, the environment for Columbia River Basin anadromous salmonids, including those using Willow Creek and the Willow Creek Arm, has been dramatically affected by the development and operation of the FCRPS. Forestry, farming, grazing, road construction, hydrosystem development, mining, and urbanization have radically reduced the quantity and quality of historic habitat conditions in much of the basin. For more than 100 years, hatcheries in the Pacific Northwest have been used to replace natural production lost as a result of the FCRPS and other development, not to protect and rebuild natural populations. As a result, most salmon populations in this region are primarily hatchery fish. The traditional response to declining salmon catches was hatchery construction to produce more fish, thus allowing harvest rates to remain high and further exacerbating the effects of overfishing on the naturally produced (nonhatchery) runs mixed in the same fisheries. Changes in salmonid populations are also substantially affected by variation in the freshwater and marine environments. Ocean conditions that are a key factor in the productivity of Northwest salmonid populations appear to have been in a low phase of the cycle for some time and are likely an important contributor to the decline of many stocks. The survival and recovery of these species will depend on their ability to persist through periods of low natural survival. Additional details about these effects can be found in NMFS 2000a and OPB 2000.

Very few data are available to assess the environmental baseline in the Willow Creek Arm itself. The biological assessment notes that Willow Creek does not meet state water quality criteria for temperature and pH during summer. Habitat access into the Willow Creek Arm is unimpeded and shallow water areas, backwaters and sloughs are important to downstream migrating salmon (Zimmerman and Rasmussen 1981). Channel conditions are largely unknown but are clearly influenced by significant deliveries of fine sediment from Willow Creek and subsequent redistribution by dredging. Flow conditions within the arm are unknown but anecdotal evidence suggests that hydrological conditions affecting juvenile migration and rearing behaviors may be affected by operations of the pump station, and by operations of the FCRPS downstream.

Habitat elements conducive to juvenile rearing, such as large woody debris, shallow water habitat, and riparian vegetation are rare or absent. One inventory of riparian habitats based on aerial photography characterized the dominant riparian vegetation around Willow Creek Arm simply as a shrub type dominated by gray rabbitbrush (Tabor 1976). A more recent study (Enviroscience 1995) completed using ground-based transects describes riparian vegetation as a mix of cattail, tule, and reed canary grass on shorelines with Siberian water milfoil in ponds and bays. Important woody wetland community types included willow, balsam poplar, Russian olive, and false blue indigo. Western fragrant goldenrod, broadleaf peppergrass, creeping thistle and annual rabbit-foot grass were common herb and disturbance types. Upland types were most often rabbitbrush, sagebrush and cheatgrass. The sediment characterization report for the dredging project states that sediments from the proposed dredge prism are suitable for unconfined, open-water disposal since all detected potential chemicals were below corresponding screening criteria.

Watershed conditions in the Willow Creek basin are largely unknown although available information (OPB 2000) suggests land and water use practices such as irrigation, water withdrawals, and riparian vegetation removal upstream have resulted in fish passage obstructions and summer low flow conditions that are unable to support summer runs of anadromous fish. Further, stream sedimentation from fallow agricultural fields adjacent to Willow Creek, riparian cover removal, and livestock grazing practices are likely to have eliminated most potential spawning habitat.

Nonetheless, salmonid fingerlings have been identified within the Willow Creek Arm during spring[21] and anecdotal evidence suggests that steelhead may spawn upstream in Willow Creek, at least during high runoff years. Fish monitoring data that BAIC proposes to collect as part of this project are intended help the COE and NMFS determine whether this assumption is correct.

Based on this assessment, the environmental baseline in the Willow Creek Arm is currently "non-functional" as a juvenile rearing area, a juvenile migration area, and an adult migration corridor. The current status of each species, as described in Section 2.1.2, indicates that the species-level biological requirements are not being met for any of the seven listed species considered in this consultation. Improvements in the environmental baseline and survival rates (assessed over the entire life cycle) are necessary to meet species-level biological requirements in the future.

Continuing FCRPS actions initiated in the lower and mid-Columbia River in response to consultation for the listed stocks are expected to work toward slowing this trend toward extinction for the salmon and steelhead species considered in this consultation. The status of these species is such that a significant improvement in environmental conditions over those currently available under the environmental baseline is needed to ensure long-term survival. Any further degradation of these conditions would have a significant impact due to the risk listed salmon and steelhead presently face under the environmental baseline.

2.1.3 Analysis of Effects

2.1.3.1 Effects of the Proposed Action

Dredging. Dredging and disposal of dredged material speed up the natural processes of sediment erosion, transportation and deposition (Morton 1977). The physical effects to the river system from dredging and disposal briefly summarized are temporary increases in turbidity, changes in bottom topography with resultant changes in water circulation, and changes in the mechanical properties of the sediment at the dredge and disposal sites (Nightingale and Simenstad 2001, Hershman 1999, Morton 1977). The significance of the effect is a function of the ratio of the size of the dredged area to the size of the bottom area and water volume (Morton 1977).

Potential effects to ESA-listed salmonids from the proposed action include both direct and

[21] Memorandum from Lou Fred, Oregon Department of Fish and Wildlife, to Files (re: Willow Creek)(June 17, 1977) describing two seine hauls made near the highway fills and pump intake containing a mixture of salmon fingerlings and warmwater fish and suggesting that young salmon and steelhead may enter and rear in Willow Creek.

indirect effects. Potential direct effects include entrainment of juvenile fish (Nightingale and Simenstad 2001, Armstrong et al. 1982, Tutty 1976, Dutta and Sookachoff 1975a, Boyd 1975) and mortality from exposure to suspended sediments (turbidity) (Nightingale and Simenstad 2001). Potential indirect effects include behavioral and sub-lethal affects from exposure to increased turbidity (Nightingale and Simenstad 2001, Emmett et al. 1988, Gregory 1988, Servizi 1988, Sigler 1988, Berg and Northcote 1985, Sigler et al. 1984, Whitman et al. 1982), loss of benthic food sources resulting from dredging and disposal of dredged material (Nightingale and Simenstad 2001, Morton 1977), and cumulative effects of increased agricultural activity at sites adjacent to the action area.

The proposed hydraulic suction dredging may entrain juvenile salmonids. When juvenile salmonids come within the "zone of influence" of the cutter head, they may be drawn into the suction pipe (Dutta 1976, Dutta and Sookachoff 1975a). Dutta (1976) reported that salmon fry were entrained by suction dredging in the Fraser River and recommended that suction dredging during juvenile migration be controlled. Almost 99 percent of entrained juveniles were killed in studies by Braun (1974a, 1974b). Suction dredging operations caused "a partial destruction of the anadromous salmon fishery resource of the Fraser River" (Dutta and Sookachoff 1975b). Suction pipeline dredges operating in the Fraser River during fry migration took substantial numbers of juveniles (Boyd 1975). As a result of these studies, the Canadian government issued dredging guidelines for the Fraser River to minimize the potential for entrainment (Boyd 1975). Further testing in 1980 by Arseneault (1981) found entrainment of chum and pink salmon but in low numbers relative to the total of salmonids outmigrating (0.0001 to 0.0099 percent).

The COE's Portland District conducted extensive sampling within the Columbia River in 1985-88 (Larson and Moehl 1990) and again in 1997 and 1998. In the 1985-88 study no juvenile salmon were entrained, and in the 1997-98 study only two juvenile salmon were entrained. Examination of fish entrainment rates in Grays Harbor from 1978 to 1989 detected only one juvenile salmon entrained (McGraw and Armstrong 1990). Dredging was conducted outside peak migration times. No evidence of fish mortality was found while monitoring dredging activities along the Atlantic Intracoastal Waterway (Stickney 1973).

These Fraser and Columbia River studies examined deep-water areas associated with main channels. There is little information on the extent of entrainment in shallow water areas, such as those associated with the proposed action. Further information is needed to determine if suction dredging in these shallow water areas may entrain juvenile salmonids.

In areas of coarse sand, NMFS expects the amount of turbidity generated from the dredging process to be very small and confined to the area close to the cutterhead. In areas of fine and medium-grained sediments, turbidity and resuspension of toxic sediments during dredging and disposal is much greater. The particle size distribution test report for the dredging project describes the top 2.5 feet of the sediment matrix (i.e., the proposed depth of proposed dredging area) as "slightly clayey, sandy silt," a medium textured sediment, overlying compact, silty sand.[22] Thus, NMFS assumes considerable turbidity may result from the proposed dredging.

---

[22] Hart Crowser (2001), at p.3 and Appendix A.

Suspended sediment and turbidity influences on fish reported in the literature range from beneficial to detrimental. Elevated total suspended solids (TSS) conditions have been reported to enhance cover conditions, reduce piscivorous fish/bird predation rates, and improve survival. Elevated TSS conditions have also been reported to cause physiological stress, reduce growth, and reduce survival. Of key importance in considering the detrimental effects of TSS on fish are the frequency and the duration of the exposure, not just the TSS concentration.

Behavioral avoidance of turbid waters may be one of the most important effects of elevated suspended sediments (DeVore et al. 1980, Birtwell et al. 1984, Scannell 1988). Salmonids have been observed to move laterally and downstream to avoid turbid plumes (McLeay et al. 1984, Sigler et al. 1984, Lloyd 1987, Scannell 1988, Servizi and Martens 1991). Juvenile salmonids tend to avoid streams that are chronically turbid, such as glacial streams or those disturbed by human activities, except when the fish must traverse these streams along migration routes (Lloyd et al. 1987). In addition, a potential positive effect is providing refuge and cover from predation (Gregory and Levings 1998).

Fish that remain in turbid, or elevated TSS, waters experience a reduction in predation from piscivorous fish and birds (Gregory and Levings 1998). In habitats with intense predation pressure, this provides a beneficial trade-off (e.g., enhanced survival) to the cost of potential physical effects (e.g., reduced growth). Turbidity levels of about 23 Nephalometric Turbidity Units (NTU) have been found to minimize bird and fish predation risks (Gregory 1993). Exposure duration is a critical determinant of the occurrence and magnitude of physical or behavioral effects (Newcombe and MacDonald 1991). Salmonids have evolved in systems that periodically experience short-term pulses (days to weeks) of high suspended sediment loads, often associated with floods, and are adapted to such high pulse exposures. Adult and larger juvenile salmonids appear to be little affected by the high concentrations of suspended sediments that occur during storm and snowmelt runoff episodes (Bjornnand Reiser 1991). However, chronic exposure can cause physiological stress that can increase maintenance energy and reduce feeding and growth (Redding et al. 1987, Lloyd 1987, Servizi and Martens 1991).

Turbidity, at moderate levels, has the potential to reduce primary and secondary productivity, and at high levels, has the potential to injure and kill adult and juvenile fish, and may also interfere with feeding (Spence et al. 1996, Bjornn and Reiser 1991). Other behavioral effects on fish, such as gill flaring and feeding changes, have been observed in response to pulses of suspended sediment (Berg and Northcote 1985). Fine redeposited sediments also have the potential to reduce primary and secondary productivity (Spence et al. 1996), and to reduce incubation success (Bell 1991) and cover for juvenile salmonids (Bjornn and Reiser 1991). Reduction or loss of primary and secondary productivity can initiate a chain of biological events for salmon including reduction of benthic invertebrates, loss of preferred food resources, altered trophic and competitive relationships, altered community composition, direct mortality, and reduced populations. Further study is warranted on shallow water habitat dredging. However, it is likely that use of proposed conservation measures will limit any turbidity effects to a low level of incidence at the dredge site and should minimize turbidity exposure to at-risk juvenile salmonids. NMFS expects adult salmon to avoid the turbidity plume.

As noted above, sediments from the proposed dredge prism are suitable for unconfined, open-water disposal since all detected potential chemicals were below corresponding screening criteria. Nonetheless, NMFS is concerned about the potential effects of sediment contaminants, particularly sublethal and cumulative effects. Direct and indirect adverse effects may be exhibited at very low concentrations for some contaminants (Brewer et al. 2001, Moore and Waring 2001, Beauvais et al. 2000, Johnson 2000, Scholz et al. 2000, NMFS 1998, Waring and Moore 1997, Zuranko et al. 1997, Moore and Waring 1996, Meador 1991).

Return Flow from Upland Dewatering Site. Temporary placement of dredged material in the settling basin for dewatering before upland disposal will result in return flow of interstitial water to the Willow Creek Arm. The opportunity for these flows to cause erosion will be eliminated by ensuring that they are contained in a conveyance system extending all the way to the ordinary high water line. All erodible elements of the conveyance system will be adequately stabilized to prevent erosion. Any sediment remaining in the return flow will be contained in the silt curtained work area and will diminish further due to pumping. Some dredged material is likely to be deposited in low current areas of the arm and may remain for extended periods.

Construction Equipment. As with all construction activities, accidental release of fuel, oil, and other contaminants may occur. Operation of the dredge equipment requires the use of fuel, lubricants, etc., which if spilled into a water body or the adjacent riparian zone could injure or kill aquatic organisms. Petroleum-based contaminants (such as fuel, oil, and some hydraulic fluids) contain polycyclic aromatic hydrocarbons (PAHs) which can cause acute toxicity to salmonids at high levels of exposure and can also cause chronic lethal as well as acute and chronic sublethal effects to aquatic organisms (Neff 1985).

Riparian Restoration. To the extent that restoration of woody vegetation along part of the Willow Creek Arm shoreline involves streambank shaping or soils disturbance, it may cause a temporary decreases in water quality (sedimentation and turbidity) and may adversely affect existing riparian and upland vegetation. However, any such impacts will be temporary in nature and eliminated by establishment of the new vegetation. The long-term effects of successful revegetation will be streambank stabilization, reduced sedimentation, increased stream shading, reduce nutrient inflow, and a future source of large woody debris.

Fish Monitoring. The proposed monitoring plan includes efforts to determine the timing, distribution and relative abundance of salmon, fish predators (e.g., smallmouth bass, northern pikeminnow) and other fish species occurrence in the Willow Creek Arm during the irrigation season. Other data will be collected to characterize water temperatures and dissolved oxygen, throughout the Willow Creek Arm. This information is intended to help evaluate any observed patterns of juvenile salmon distribution, the amount or extent of take likely due to pump station operations, and to demonstrate the effectiveness of proposed conservation measures. A variety of sampling methods (beach seining, purse seining, and electrofishing) will be used to obtain this information.

Capturing and handling fish causes stress—though they typically recover fairly rapidly from the process and therefore the overall effects of the procedure are generally short-lived. The primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the river and wherever the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 64.4°F or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps if the traps are not emptied on a regular basis. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis.

Based on prior experience with the research techniques and protocols that would be used to conduct the proposed monitoring, no more than five percent of the juvenile salmonids encountered are likely to be killed as an indirect result of being captured and handled and, in most cases, that figure will not exceed three percent. In any case, the applicant will employ the mitigation measures described in this Opinion and thereby keep adverse effects to a minimum. Finally, any fish indirectly killed by the monitoring activities in the proposed permits may be retained as reference specimens or used for analytical research purposes.

Electrofishing is a process by which an electrical current is passed through water containing fish in order to stun them—thus making them easier to capture. It can cause a suite of effects ranging form simple harassment to actually killing the fish (adults and juveniles) in an area where it is occurring. The amount of unintentional mortality attributable to electrofishing may vary widely depending on the equipment used, the settings on the equipment, and the expertise of the technician. Electrofishing can have severe effects on adult salmonids. Spinal injuries in adult salmonids from forced muscle contraction have been documented. Sharber and Carothers (1988) reported that electrofishing killed 50 percent of the adult rainbow trout in their study. The long-term effects electrofishing has on both juvenile and adult salmonids are not well understood, but long experience with electrofishing indicates that most impacts occur at the time of sampling and are of relatively short duration.

The effects electrofishing will have on MCR steelhead would be limited to the direct and indirect effects of exposure to an electric field, capture by netting, holding captured fish in aerated tanks, and the effects of handling associated with transferring the fish back to the river (see the next subsection for more detail on capturing and handling effects). Most of the studies on the effects of electrofishing on fish have been conducted on adult fish greater than 300 mm in length (Dalbey et al. 1996). The relatively few studies that have been conducted on juvenile salmonids indicate that spinal injury rates are substantially lower than they are for large fish. Smaller fish intercept a smaller head-to-tail potential than larger fish (Sharber and Carothers 1988) and may therefore be subject to lower injury rates (e.g., Hollender and Carline 1994, Dalbey et al. 1996, Thompson et al. 1997). McMichael et al. (1998) found a 5.1% injury rate for juvenile MCR steelhead captured by electrofishing in the Yakima River subbasin. The incidence and severity of electrofishing damage is partly related to the type of equipment used and the waveform produced (Sharber and Carothers 1988, McMichael 1993, Dalbey et al. 1996, Dwyer and White 1997). Continuous direct current (DC) or low-frequency ($\leq$30 Hz) pulsed DC have been recommended for electrofishing (Fredenberg 1992, Snyder 1992, 1995, Dalbey et al. 1996) because lower spinal injury rates, particularly in salmonids, occur with these waveforms (Fredenberg 1992, McMichael 1993, Sharber et al. 1994, Dalbey et al. 1996). Only a few recent studies have examined the long-term effects of electrofishing on salmonid survival and growth (Ainslie et al. 1998, Dalbey et al. 1996). These studies indicate that although some of the fish suffer spinal injury, few die as a result. However, severely injured fish grow at slower rates and sometimes they show no growth at all (Dalbey et al. 1996).

NMFS' electrofishing guidelines (NMFS 2000b) will be followed in all surveys requiring this procedure. The guidelines require that field crews be trained in observing animals for signs of stress and shown how to adjust electrofishing equipment to minimize that stress. Electrofishing is used only when other survey methods are not feasible. All areas for stream and special needs surveys are visually searched for fish before electrofishing may begin. Electrofishing is not done in the vicinity of redds or spawning adults. All electrofishing equipment operators are trained by qualified personnel to be familiar with equipment handling, settings, maintenance, and safety. Operators work in pairs to increase both the number of fish that may be seen and the ability to identify individual fish without having to net them. Working in pairs also allows the monitoring team to net fish before they are subjected to higher electrical fields. Only DC units will be used, and the equipment will be regularly maintained to ensure proper operating condition. Voltage, pulse width, and rate will be kept at minimal levels and water conductivity will be tested at the start of every electrofishing session so those minimal levels can be determined. Due to the low settings used, shocked fish normally revive instantaneously. Fish requiring revivification will receive immediate, adequate care.

The preceding discussion focused on the effects of using a backpack unit for electrofishing and the ways those effects will be mitigated. However, for this project, the electrofishing units will be mounted on a boat. These units often use more current than backpack electrofishing equipment because they need to cover larger (and deeper) areas and, as a result, can have a greater impact on fish. In addition, the environmental conditions in larger, more turbid waters can limit the monitoring team's ability to minimize impacts on fish. For example, in areas of lower visibility it is difficult for observers to detect the presence of adults and thereby take steps to avoid them. Because of its greater potential to harm fish, and because NMFS has not published appropriate guidelines, boat electrofishing has not been given a general authorization under NMFS' recent ESA section 4(d) rules. However, it is expected that guidelines for safe boat electrofishing will be in place in the near future. And in any case, the applicant will use all available means to ensure that a minimum number of fish are harmed, including long-established fish handling protocols incorporated into this Opinion.

2.1.3.2 Effects on Critical Habitat.

The purpose of this part of the effects assessment is to determine whether any of the constituent elements of critical habitat are likely to be adversely modified or destroyed under the proposed action. Critical habitat types in the action area all share the following essential features. No data are available to quantify these effects, although most are likely to be brief, minor, and will occur at times and timed to occur at times that are least sensitive for the species life-cycle. Data are not available to assess whether the long-term effects of frequent dredging just prior to the beginning of the juvenile migration season prevent full recovery of benthic habitats and preferred salmonid food resources, although proposed conservation measures and riparian mitigation activities are likely to avoid or offset this possibility.

Water quality – turbidity will increase slightly; low concentrations of toxic organic compounds will be released; biological and chemical oxygen demand will increase; light penetration, photosynthetic oxygen production, oxygen concentration, and pH will decrease.
Water quantity – not likely to be adversely affected.
Water temperature – may increase slightly due to turbidity and suspended solids.

Water velocity – flows will increase in dredge channel and decrease in shoal areas; flushing and mixing patterns may change while pumping is underway.
Cover/shelter – low levels of turbidity may provide additional cover from predators, salmonids will avoid areas with high turbidity.
Food – sedimentation (a condition that is generally more harmful than turbidity) may alter benthic production and shift the composition and abundance of prey sources by reducing the diversity of aquatic insects and other invertebrate prey.
Riparian vegetation – restoration efforts will change water edge habitat slightly, terrestrial insect and other allochthonous organic matter inputs may increase.
Space – shallow water habitat will be temporarily reduced.
Migration conditions – environmental cues for migration may be slightly altered.

2.1.3.3 Cumulative Effects

Cumulative effects are defined in 50 CFR 402.02 as "those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation." Other activities within the watershed have the potential to impact fish and habitat within the action area. Future Federal actions, including the ongoing operation of hydropower systems, hatcheries, fisheries, and land management activities are being (or have been) reviewed through separate section 7 consultation processes.

Between 1990 and 1998, human population in the Columbia Plateau region had a growth rate of 14.4 percent, a pattern very similar to the state's pattern of growth (OPB 2000). Further, BAIC has announced plans to enlarge its agricultural operation in the vicinity of the action area. Thus NMFS assumes that future private and State actions will continue within the action area, but at increasingly higher levels as population density climbs and agricultural operations expand.

2.1.4 Conclusion

After reviewing the best available scientific and commercial information available regarding the current status of the seven ESUs considered in this consultation, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' opinion that the action, as proposed, is not likely to jeopardize the continued existence of these species, and is not likely to destroy or adversely modify designated critical habitat.

Our conclusions are based on the following considerations: (1) Taken together, the conservation measures applied to the dredging and spoil dewatering components of the proposed project will ensure that any short-term effects to ESA-listed salmon and the essential features of their habitat will be short-term, minor, and timed to occur at times when the fewest number of listed salmon are likely to be present; (2) conservation measures applied to the fish study portion of this action will avoid or minimize adverse affects to listed salmon by requiring all monitoring crew members to follow consistent adhere to NMFS fish handling and reporting guidelines at all times; (3) the riparian restoration component of the proposed project is expected to favor natural habitat forming processes and have beneficial long-term effects; and (4) the individual and combined effects of all parts of the proposed action are not expected to impair currently properly functioning habitats, appreciably reduce the functioning of already impaired habitats, or retard the long-term progress of impaired habitats toward proper functioning condition essential to the long-term survival and recovery at the population or ESU scale.

2.1.5 Conservation Recommendations

Section 7 (a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Conservation recommendations are discretionary measures suggested to minimize or avoid the potential adverse effects of a proposed action on ESA-listed species, to minimize or avoid adverse modification of critical habitat, to develop additional information, or to assist the Federal agencies in complying with the obligations under Section 7(a)(1) of the ESA. NMFS believes the following conservation recommendation is consistent with these obligations, and therefore should be carried out by the COE.

As described in Section 2.1.2.2 above, the environmental baseline for Willow Creek is poor. Critical habitat types for juvenile rearing areas, juvenile migration corridors, and adult migration corridors are nonfunctional. NMFS, therefore, recommends that the COE assess the Willow Creek basin to determine which immediate and long-term actions are necessary to improve the survival and recovery of listed Columbia Basin consistent with measures identified in the Basinwide Recovery Strategy. Specifically, the COE should work in coordination with NMFS, nonfederal partners, and other entities as necessary to develop a database of habitat conditions, a set of priority actions that are most likely to accomplish the following goals and produce significant biological benefits in the near term (10 years or less), and a sequence to accomplish those actions:

- Restore flows to improve tributary and mainstem habitat productivity.
- Ensure that all water diversions have fish screens meeting NMFS' criteria.
- Reduce or eliminate passage obstructions and sources of habitat degradation, such as temporary berms, unladdered water diversion structures, and culverts.
- Reestablish riparian vegetation at appropriate locations; add large woody debris.
- Abate non-point pollution.
- Rehabilitate historic and existing wetlands.

The Basinwide Recovery Strategy also established these specific habitat improvement action priorities for the mainstem of the Columbia River between Chief Joseph Dam and Bonneville Dam, the reach that includes the Willow Creek Arm:

- Add large woody debris; create shallow water areas; enhance alcove, slough and side channel connections to the main channel; establish emergent aquatic plants in shallow water areas; stabilize reservoir water levels.
- Restore habitat; acquire riparian corridors; modify flow regimes; reduce non-point pollution; develop improvement plans for all reaches.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects, or those that benefit listed salmon and steelhead or their habitats, NMFS requests notification of the achievement of any conservation recommendations when the COE submits its annual report describing achievements of the fish monitoring program during the previous year.

2.1.6 Reinitiation of Consultation

This concludes formal consultation on the Willow Creek dredging project as outlined in the biological assessment submitted in November 2000. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: 1) The amount or extent of taking specified in the Incidental Take Statement is exceeded, or is expected to be exceeded; 2) new information reveals effects of the action may affect ESA-listed species in a way not previously considered; 3) the action is modified in a way that causes an effect on listed species that was not previously considered; or 4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

If the applicant fails to provide specified monitoring information by the required date, NMFS will consider that a modification of the action that causes an effect on ESA-listed species not previously considered and triggers reinitiation of consultation. To reinitiate consultation, contact the Habitat Conservation Division (Oregon State Office) of NMFS.

2. INCIDENTAL TAKE STATEMENT

Sections 4 (d) and 9 of the ESA prohibit any taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct) of listed species without a specific permit or exemption. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, and sheltering. Harass is defined as actions that create the likelihood of injuring listed species to such an extent as to significantly alter normal behavior patterns which include, but are not limited to, breeding, feeding, and sheltering. Incidental take is take of listed species that results from, but is not the purpose of, the Federal agency or the applicant carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to, and not intended as part of, the agency action is not considered prohibited taking provided that such taking is in compliance with the terms and conditions of this incidental take statement.

An incidental take statement specifies the impact of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary to minimize impacts and sets forth terms and conditions with which the action agency must comply in order to implement the reasonable and prudent measures.

2.1 Amount or Extent of Take

NMFS anticipates that the dredging project considered in this Opinion is reasonably likely to take some of the seven listed species. Effects of actions such as these are largely unquantifiable and are not expected to be measurable as long-term effects on populations. Therefore, even though NMFS expects the dredging project to cause some low level incidental take, the best scientific and commercial data available are not sufficient to enable NMFS to estimate a specific amount of incidental take. In instances such as these, NMFS designates the expected level of take as "unquantifiable."

Juvenile fish monitoring is part of the proposed action. All of the monitoring activities identified in this Opinion will take place in the Willow Creek Arm. Of the ESA-listed fish to be captured and handled during the course of the proposed monitoring, 95 percent or more are expected to survive with no long-term effects and 5 percent or less are expected to be injured or killed, including delayed mortality as a result of injury. In part, this is because the proposed methods will be minimally intrusive and of short duration. Thus, the monitoring activities will have relatively little effect on ESA-listed species and will not create any significant effects beyond those already estimated through other means in NMFS 2000a.

While NMFS expects some low level of non-lethal incidental take to occur due to the monitoring actions covered by this Opinion, the best scientific and commercial data available do not allow NMFS to estimate a specific amount of incidental take. Thus, the estimates below are derived from a projection of total catch provided by the principal investigator.[23] The estimate of non-lethal take of ESA-listed fish was calculated from total catch by applying NMFS' ratios of listed fish to non-listed fish at McNary Dam for 2001, then increased several fold to provide a conservative estimate of take in 2002. Lethal take is estimated to be 5 percent or less of the non-lethal take, as explained above. Because many of the ESUs that these actions may affect are similar in appearance, it is impossible to assign this take to groups below the species level. NMFS will update this estimate of incidental take before March 31 each year after reviewing information from the preceding year describing fish monitoring operations.

Species	Life Stage	Total Catch	Non-lethal Take ESA-Listed Fish	Lethal Take ESA-Listed Fish
Chinook salmon	juvenile	1550	20	1
Steelhead salmon	juvenile	230	10	<1
Sockeye salmon	juvenile	50	5	<1

Although the adverse effects of the monitoring are exceedingly small, the applicant will work to minimize them even further. Aside from the mitigation measures mentioned earlier, they will constantly monitor their sampling methods and results and ensure that salmonid injuries are kept to a minimum.

Adult fish monitoring may also occur as part of the proposed monitoring activities. NMFS does not anticipate that any take will be associated with adult observations. The application of information resulting from this monitoring efforts is expected to benefit the survival of ESA-listed species.

[23] Email from Bob Ellis, Ellis Ecological Services, to Marc Liverman, National Marine Fisheries Service (April 22, 2002) describing take estimates for Willow Creek Arm fish monitoring in 2002.

2.2 Effect of the Take

In the accompanying Opinion, NMFS determined that this level of anticipated take is not likely to result in jeopardy to the seven listed species of Columbia Basin salmonids considered in the Opinion or result in the destruction or adverse modification of critical habitats.

2.3 Reasonable and Prudent Measures

The measures described below are non-discretionary. They must be implemented so that they become binding conditions in order for the exemption in section 7(a)(2) to apply. The COE has the continuing duty to regulate the activities covered in this incidental take statement. If the COE fails to require the applicants to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, or fails to retain the oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse. NMFS believes that activities carried out in a manner consistent with these reasonable and prudent measures, except those otherwise identified, will not necessitate further site-specific consultation. Activities which do not comply with all relevant reasonable and prudent measures will require further individual consultation.

NMFS believes that the following reasonable and prudent measures are necessary and appropriate to minimize the likelihood of take of listed fish resulting from implementation of this opinion. These reasonable and prudent measures would also minimize adverse effects to designated critical habitat.

1. Minimize the likelihood of incidental take from maintenance dredging by avoiding or minimize disturbance to aquatic and riparian systems.

2. Minimize the likelihood of incidental take from the fish monitoring program by following NMFS protocols for safe handling of listed salmon.

3. Complete a monitoring and reporting program to ensure this Opinion is meeting its objective of minimizing the likelihood of take from permitted actions.

2.4 Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, COE must comply with the following terms and conditions, which implement the reasonable and prudent measures described above for each category of activity. These terms and conditions are non-discretionary.

1. To implement Reasonable and Prudent Measure #1 (maintenance dredging), the COE shall ensure that:
    a. All dredging will be completed during the approved in-water work period, when juvenile salmon are least likely to be in the project vicinity.
    b. A silt curtain will be used to isolate the dredge prism and contain sediments suspended during operations. The silt curtain will enclose the dredging area, pump station, and the outfall for return flow from the upland dredge spoil dewatering area.

c. A barge-mounted 8-inch hydraulic dredge will be used to complete the dredging.
d. The intake of the dredge will be operated at or below the surface of the material being removed, but may be raised a maximum of 3 feet above the bed for brief periods of purging or flushing.
e. The resulting channel will not be deeper than the authorized project depth with side slopes of the dredged area shall be graded to a maximum slope of 3 feet horizontal to 1 foot vertical to prevent the deepening of shallow water areas by sloughing.
f. Irrigation pumps will be operating during the dredging to draw any suspended sediments into the pumps rather than allow them to disperse away from the dredging area.
g. Dredged material will be disposed of next to the pump station in the upland settling basin created for that purpose.
h. Discharge water from the settling basin must be managed to ensure that it is it is conveyed back to Willow Creek Arm in a manner that does not cause erosion and is discharged into the silt fence enclosure.
i. Part of the area previously permitted and used for dredge disposal will be restored to its pre-disposal elevation and vegetated with woody species native to the area or region to compensate for the filled area below the maximum pool elevation of John Day Reservoir and any loss of benthic production associated with the dredge prism.

2. To implement Reasonable and Prudent Measure #2 (fish monitoring protocol), the COE shall ensure that:
   a. Any salmon or steelhead that is captured as part of the fish monitoring process is processed in the following manner:
      i. Each fish handled out-of-water must be anesthetized.
      ii. Anesthetized fish must be allowed to recover (e.g., in a recovery tank) before being released. Fish that are simply counted must remain in water but do not need to be anesthetized.
      iii. Listed fish must be handled with extreme care and kept in water to the maximum extent possible during sampling and processing procedures.
      iv. Holding units must contain adequate amounts of well-circulated water.
      v. When using gear that capture a mix of species, ESA-listed fish must be processed first to minimize the duration of handling stress.
      vi. The transfer of fish must be conducted using a sanctuary net that holds water during transfer, whenever necessary to prevent the added stress of an out-of-water transfer.
      vii. Salmonids must not be handled if the water temperature exceeds 70 degrees Fahrenheit at the capture site. Under these conditions, salmonids may only be identified and counted.
      viii. No salmonid may be intentionally killed or intentionally allowed to die.
      ix. Visual observation protocols must be used instead of intrusive sampling methods whenever possible. This is especially appropriate to ascertain whether anadromous fish are merely present. Snorkeling and streamside surveys will replace electrofishing procedures whenever possible.

x. Any use of electrofishing equipment must be accomplished according to NMFS eletrofishing guidelines.[24]

b. The applicant will report to NMFS whenever the authorized level of take is exceeded or as soon as circumstances indicate that such an event is imminent. Notification should be made as soon as possible, but not later than two days after the authorized level of take is exceeded. The permittee must then submit a detailed written report. Pending review of these circumstances, NMFS may suspend monitoring activities or reinitiate consultation before allowing monitoring to continue.

3. To implement Reasonable and Prudent Measure #3 (monitoring and reporting), the COE shall ensure that:
   a. Within 30 days of completing the dredging project, the applicant will submit a monitoring report to the COE and NMFS describing the applicant's success meeting their permit conditions. This report will consist of the following information.
   b. Project identification.
      i. Permit number;
      ii. applicant's name;
      iii. project name;
      iv. starting and ending dates for work performed under the permit; and
      v. the COE contact person.
   c. A narrative assessment of the project's effects on natural stream function.
   d. Photographic documentation of environmental conditions at the dredge site, the spoil disposal area, and at the dredge spoil restoration site. Photographs will be taken before, during and within 30 days after project completion, including any habitat improvements at the restoration site.
      i. Photographs will include general project location views and close-ups showing details of the project area and project.
      ii. Each photograph will be labeled with the date, time, photo point, project name, the name of the photographer, and a comment describing the photograph's subject.
      iii. Relevant habitat conditions include characteristics of streambanks, riparian vegetation, flows, water quality, and other visually discernable environmental conditions at the project area, and upstream and downstream of the project.
   e. By January 31 of each year for the duration of the permit, the applicant will provide NMFS with an annual monitoring report that describes the results of any dredging completed that year, and the results of the Willow Creek fish monitoring effort. The report will include the following information.
      i. Photographs of the restoration site taken that year to document the success of revegetation efforts.

[24] NMFS, Northwest Region, Electrofishing Guidelines (1998) (http://www.nwr.noaa.gov/1salmon/salmesa/pubs/electrog.pdf).

ii. A copy of all fish monitoring data collected during the previous year, including:
   (1) The total number of fish taken from each sampling run
   (2) An estimate of the number of ESA-listed fish taken from each sampling run, the condition of the fish, the manner of take, and the dates and location of take
   (3) If electrofishing was used, a copy the electrofishing logbook.
   (4) A description of measures taken to minimize disturbance to listed fish and the effectiveness of these measures.
   (5) A description of the effects of the monitoring activities on listed fish.
   (6) The disposition of listed fish in the event of mortality.
   (7) A brief narrative of the circumstances surrounding listed fish injuries or mortalities.

iii. Copies of any data or analyses that the applicant may produce of physical, chemical, and biological habitat features within Willow Creek as a result of the fish monitoring part of this action.

iv. Copies of any evaluation of information that tends to explain the role of maintenance dredging or pump station operations on essential salmonid behaviors, and the COE evaluation of the quality of the data and analyses provided are also of interest.

v. Any steps that are taken to coordinate this monitoring with other scientific work.

vi. Any recommendation provided by the principle investigators, applicant or the COE for improving the effectiveness or efficiency of the fish monitoring program.

f. The annual report will be submitted to:

   Branch Chief - Portland
   National Marine Fisheries Service
   Attn: OSB2001-0016
   525 NE Oregon Street
   Portland, OR 97232

g. The COE and the applicant will meet with NMFS by March 31 each year to discuss the fish monitoring report and any actions that may be necessary to make the fish monitoring program more effective or efficient.

h. Failure to provide timely monitoring may trigger reinitiation. If the applicant fails to provide specified monitoring information by the required date, NMFS may consider that a modification of the action that causes an effect on listed species not previously considered and triggers reinitiation of consultation.

3. MAGNUSON-STEVENS ACT

3.1 Background

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established procedures designed to identify, conserve, and enhance essential fish habitat (EFH) for those species regulated under a Federal fisheries management plan. Pursuant to the MSA:

- Federal agencies must consult with NMFS on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH (§305(b)(2)).
- NMFS must provide conservation recommendations for any Federal or State action that would adversely affect EFH (§305(b)(4)(A)).
- Federal agencies must provide a detailed response in writing to NMFS within 30 days after receiving EFH conservation recommendations. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NMFS EFH conservation recommendations, the Federal agency must explain its reasons for not following the recommendations (§305(b)(4)(B)).

EFH means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (MSA §3). For the purpose of interpreting this definition of EFH: Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle (50 C.F.R. 600.10). Adverse effect means any impact which reduces quality and/or quantity of EFH, and may include direct (*e.g.*, contamination or physical disruption), indirect (*e.g.*, loss of prey or reduction in species fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 C.F.R. 600.810).

EFH consultation with NMFS is required regarding any Federal agency action that may adversely affect EFH, including actions that occur outside EFH, such as certain upstream and upslope activities.

The objectives of this EFH consultation are to determine whether the proposed action would adversely affect designated EFH and to recommend conservation measures to avoid, minimize, or otherwise offset potential adverse effects to EFH.

3.2 Identification of EFH

Pursuant to the MSA the Pacific Fisheries Management Council (PFMC) has designated EFH for federally-managed fisheries within the waters of Washington, Oregon, and California. Designated EFH for groundfish and coastal pelagic species encompasses all waters from the mean high water line, and upriver extent of saltwater intrusion in river mouths, along the coasts of Washington, Oregon and California, seaward to the boundary of the U.S. exclusive economic zone (370.4 km)(PFMC 1998a, 1998b). Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers (as identified by the PFMC 1999), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years)(PFMC 1999). In estuarine and marine areas, designated salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone (370.4 km) offshore of Washington, Oregon, and California north of Point Conception to the Canadian border (PFMC 1999).

Detailed descriptions and identifications of EFH are contained in the fishery management plans for groundfish (PFMC 1998a), coastal pelagic species (PFMC 1998b), and Pacific salmon (PFMC 1999). Casillas et al. (1998) provides additional detail on the groundfish EFH habitat complexes. Assessment of the potential adverse effects to these species' EFH from the proposed action is based, in part, on these descriptions and on information provided by the COE.

3.3 Proposed Actions

The proposed action and action area are detailed above in Section 1 of this Opinion. The action area includes habitats that have been designated as EFH for various life-history stages of Pacific salmon.

3.4 Effects of Proposed Action

As described in detail in Section 2.1.3.1 of this Opinion, the proposed action may result in short- and long-term adverse effects to a variety of habitat parameters. These adverse effects are:

1. Turbidity
2. Disruption of species life stage functions due to in-water work
3. Introduction of pollutants into waterbodies
4. Modification of stream morphology

3.5 Conclusion

NMFS concludes that the proposed action would adversely affect the EFH for Pacific salmon species.

3.6 EFH Conservation Recommendations

Pursuant to Section 305(b)(4)(A) of the MSA, NMFS is required to provide EFH conservation recommendations to Federal agencies regarding actions which may adversely affect EFH. The Terms and Conditions 1.a. through 1.i. in Section 2.2.3 are generally applicable to designated EFH for Pacific salmon, and address these adverse effects. Consequently, NMFS recommends that they be adopted as EFH conservation measures.

3.7 Statutory Response Requirement

Pursuant to the MSA (§305(b)(4)(B)) and 50 C.F.R. 600.920(j), Federal agencies are required to provide a detailed written response to NMFS' EFH conservation recommendations within 30 days of receipt of these recommendations. The response must include a description of measures proposed to avoid, mitigate, or offset the adverse impacts of the activity on EFH. In the case of a response that is inconsistent with the EFH conservation recommendations, the response must explain the reasons for not following the recommendations, including the scientific justification for any disagreements over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects.

3.8 Supplemental Consultation

The COE must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a manner that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH conservation recommendations (50 C.F.R. 600.920(k)).

4. LITERATURE CITED

Ainslie, B. J., J. R. Post, A. J. Paul, 1998: Effects of Pulsed and Continuous DC Electrofishing on Juvenile Rainbow Trout. North American Journal of Fisheries Management: Vol. 18, No. 4, pp. 905–918.

Armstrong, D. A., B. G. Stevens, and J. C. Hoeman. 1982. Distribution and abundance of Dungeness crab and *Crangon* shrimp, and dredged-related mortality of invertebrates and fish in Grays Harbor, Washington. Technical Report School of Fisheries. University of Washington, Washington Department of Fisheries, and Seattle District Corps of Engineers.

Arseneault, J. S. 1981. Memorandum to J. S. Mathers on the result of the 1980 dredge monitoring program. Fisheries and Oceans, Government of Canada.

Beauvais, S. L., S. B. Jones, S. K. Brewer, and E. E. Little. 2000. Physiological measures of neurotoxicity of diazinon and malathion to larval rainbow trout (Oncorhynchus mykiss) and their correlations with behavioral measures. Environmental Toxicology and Chemistry 19(7): 1875-1880.

Bell, M. C. 1991. Fisheries handbook of Engineering requirements and biological criteria. Fish Passage Development and Evaluation Program. U.S. Army Corps of Engineers. North Pacific Division.

Berg, L. and T. G. Northcote. 1985. "Changes In Territorial, Gill-Flaring, and Feeding Behavior in Juvenile Coho Salmon (*Oncorhynchus kisutch*) Following Short-Term Pulses of Suspended Sediment." Canadian Journal of Fisheries and Aquatic Sciences 42:1410-1417.

Birtwell, I. K., G. F. Hartman, B. Anderson, D. J. McLeay, and J. G. Malick. 1984. "A Brief Investigation of Arctic Grayling (Thymallus arcticus) and Aquatic Invertebrates in the Minto Creek Drainage, Mayo, Yukon Territory: An Area Subjected to Placer Mining." Canadian Technical Report of Fisheries and Aquatic Sciences 1287.

Bjornn, T. C., and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 *in* W.R. Meehan (editor). Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19:83-138.

Bottom, D. L., P. J. Howell, and J. D. Rodgers. 1985. The effects of stream alterations on salmon and trout habitat in Oregon. Oregon Department of Fish and Wildlife, Portland.

Boyd, F. C. 1975. Fraser River dredging guide. Technical Report Series No. PAC/T-75-2. Fisheries and Marine Service, Environment Canada.

Braun, F. 1974a. Monitoring the effects of hydraulic suction dredging on migrating fish in the Fraser River Phase I. Department of Public Works, Pacific Region, Canada.

Braun, F. 1974b. Monitoring the effects of hydraulic suction dredging on migrating fish in the Fraser River Phase II. Department of Public Works, Pacific Region, Canada.

Brewer, S. K., E. E. Little, A. J. DeLonay, S. L. Beauvais, S. B. Jones, and M. R. Ellersieck. 2001. Behavioral dysfunction correlate to altered physiology in rainbow trout (*Oncorhynchus mykiss*) exposed to cholinesterase-inhibiting chemicals. Archives of Environmental Contamination and Toxicology 40:70-76.

Brown, C. L. and R. Clark. 1968. Observations on dredging and dissolved oxygen in a tidal waterway. Water Resources Research 4(6):1381-1384.

Bugert, R., P. LaRiviere, D. Marbach, S. Martin, L. Ross, and D. Geist. 1990. 1989 Annual Report of Lower Snake River Compensation Plan, Salmon Hatchery Evaluation Program, to U.S. Fish and Wildlife Service (Cooperative Agreement 14-16-0001-89525).

Busack, C. 1991. Genetic evaluation of the Lyons Ferry Hatchery stock and wild Snake River fall chinook. Washington Department of Fisheries, Report to ESA Administrative Record for Fall Chinook Salmon, Olympia.

Busby, P., and 10 co-authors. 1999. Updated status of the review of the Upper Willamette River and Middle Columbia River ESUs of steelhead (*Oncorhynchus mykiss*). National Marine Fisheries Service, Northwest Fisheries Science Center, West Coast Biological Review Team, Seattle, Washington.

CBFWA (Columbia Basin Fish and Wildlife Authority). 1990. Snake River subbasin (mainstem from mouth to Hells Canyon Dam) salmon and steelhead production plan. Columbia Basin Fish and Wildlife Authority, Northwest Power Planning Council, Portland, Oregon.

Chapman, D., A. Giorgi, M. Hill, A. Maule, S. McCutcheon, D. Park, W. Platts, K. Prat, J. Seeb, L. Seeb, and others. 1991. Status of Snake River chinook salmon. Don Chapman Consultants, Inc., Boise, Idaho, for Pacific Northwest Utilities Conference Committee.

Chapman, D., C. Pevan, T. Hillman, A. Giorgi, and F. Utter. 1994. Status of summer steelhead in the mid-Columbia River. Don Chapman Consultants, Inc., Boise, Idaho.

Chapman, D., C. Peven, A. Giorgi, T. Hillman, and F. Utter. 1995. Status of spring chinook salmon in the mid-Columbia River. Don Chapman Consultants, Inc., Boise, Idaho.

Cooney, T. D. 2000. UCR steelhead and spring chinook salmon quantitative analysis report. Part 1: run reconstructions and preliminary assessment of extinction risk. National Marine Fisheries Service, Hydro Program, Technical Review Draft, Portland, Oregon. December 20.

Corps (U.S. Army Corps of Engineers). 1989. Annual fish passage report, Columbia and Snake river projects. Corps, Portland District, Portland, Oregon, and Walla Walla District, Walla Walla, Washington.

Dalbey, S. R., T. E. McMahon, and W. Fredenberg. 1996. Effect of electrofishing pulse shape and electrofishing-induced spinal injury to long-term growth and survival of wild rainbow trout. North American Journal of Fisheries Management 16:560-569.

Darnell, R. M. 1976. Impacts of construction activities in wetlands of the United States. Report Number EPA-600/3-76-045, U.S. Environmental Protection Agency, Corvallis, Oregon.

DeVore, P. W., L. T. Brooke, and W. A. Swenson. 1980. "The Effects of Red Clay Turbidity and Sedimentation on Aquatic Life In the Nemadji River System. Impact of Nonpoint Pollution Control on Western Lake Superior." S. C. Andrews, R. G. Christensen, and C. D. Wilson. Washington, D.C., U.S. Environmental Protection Agency. EPA Report 905/9-79-002-B.

Dutta, L. K. 1976. Dredging: Environmental effects and technology. Pages 301-319 in Proceedings of WODCON VII. World Dredging Conference, San Pedro, California.

Dutta, L. K. and P. Sookachoff. 1975a. Assessing the impact of a 24" suction pipeline dredge on chum salmon fry in the Fraser River. Fish. And Marine Serv., Environment Canada, Technical Report Series No. PAC/T-75-26. 24 p.

Dutta, L. K. and P. Sookachoff. 1975b. A review of suction dredge monitoring in the lower Fraser River, 1971-1975. Fish. And Marine Serv., Environment Canada, Technical Report Series No. PAC/T-75-27. 100 p.

Dwyer, W. P. and R. G. White,. 1997. Effect of Electroshock on Juveline Arctic Grayling And Yellowstone Cutthroat Trout Growth 100 Days after Treatment. North American Journal of Fisheries Management 17:174-177

Emmet, R. L., G. T. McCabe, Jr. and W. D. Muir. 1988. Effects of the 1980 Mount St. Helens eruption on Columbia River estuarine fishes: implications for dredging on Northwest estuaries. Pages 74-91 in C. A. Simenstad (ed.). Effects of dredging on anadromous Pacific coast fishes. Washington Sea Grant Program. Washington State University. Seattle, Washington.

Environscience. 1995. John Day Pool vegetation study. Technical Report DACW57-94-C-0066. Prepared for the Department of the Army, Portland District Corps of Engineers, Portland, Oregon.

Evermann, B. W. 1895. A preliminary report upon salmon investigations in Idaho in 1894. U.S. Fish Commission Bulletin 15:253-284.

Federal Caucus. 2000. Conservation of Columbia basin fish: final basinwide salmon recovery strategy. <*http://www.salmonrecovery.go*v> December.

Ford, M., P. Budy, C. Busack, D. Chapman, T. Cooney, T. Fisher, J. Geiselman, T. Hillman, J. Lukas, C. Peven, C. Toole, E. Weber, and P. Wilson. 1999. UCR steelhead and spring chinook salmon population structure and biological requirements. National Marine Fisheries Service, Northwest Fisheries Science Center, Upper Columba River Steelhead and Spring Chinook Salmon Biological Requirements Committee, Draft Report, Seattle, Washington. November 23.

Franklin, J. F., and C. T. Dyrness. 1973. Natural vegetation of Oregon and Washington. U.S. Department of Agriculture, Pacific Northwest Forest and Range Experiment Station, USDA Forest Service General Technical Report PNW-8, Portland, Oregon.

Fredenberg, W.A. 1992. Evaluation of electrofishing-induced spinal injuries resulting from field electrofishing surveys in Montana. Montana Department of Fish, Wildlife and Parks, Helena.

Fulton, L. A. 1968. Spawning areas and abundance of chinook salmon, *Oncorhynchus tshawytsch*a, in the Columbia River basin – past and present. U.S. Fish and Wildlife Service, Special Scientific Report, Fisheries 571:26.

Gregory, R. S. 1988. Effects of Turbidity on benthic foraging and predation risk in juvenile chinook salmon. Pages 64-73 *in* C. A. Simenstad (ed.). Effects of dredging on anadromous Pacific coast fishes. Washington Sea Grant Program. Washington State University. Seattle, Washington.

Gregory, R. S. 1993. Effect of turbidity on the predator avoidance behavior of juvenile chinook salmon (*Oncorhynchus tshawytcha*). Canadian J. Fish. Aquatic Sciences 50:241-246.

Gregory, R. S., and C. D. Levings. 1998. "Turbidity Reduces Predation on Migrating Juvenile Pacific Salmon." Transactions of the American Fisheries Society 127: 275-285.

Gustafson, R. G., T. C. Wainwright, G. A. Winans, F. W. Waknitz, L. T. Parker, and R. S. Waples. 1997. Status review of sockeye salmon from Washington and Oregon. National Marine Fisheries Service, Northwest Fisheries Science Center, NOAA Technical Memorandum NMFS-NWFSC-33, Seattle, Washington.

Hassemer, P. F. 1992. Run composition of the 1991-92 run-year Snake River steelhead measured at Lower Granite Dam. Idaho Fish and Game, Boise, to National Oceanic and Atmospheric Administration (Award NA90AA-D-IJ718).

Healey, M. C. 1983. Coastwide distribution and ocean migration patterns of stream- and ocean-type chinook salmon, *Oncorhynchus tshawytscha*. Canadian Field-Naturalist 97:427-433.

Healey, M. C. 1991. Life history of chinook salmon (*Oncorhynchus tshawytscha*). Pages 311-393 *in* C. Groot and L. Margolis (editors). 1991. Pacific salmon life histories. University of British Columbia Press, Vancouver, British Columbia.

Hershman, M. J. 1999. Seaport development and coastal management programs: a national overview. Coastal Management 27:271-290.

Hollender, B.A. and R. F. Carline. 1994. Injury to wild brook trout by backpack electrofishing. North American Journal of Fisheries Management 14:643-649.

Howell, P., K. Jones, D. Scarnecchia, L. LaVoy, W. Knedra, and D. Orrmann. 1985. Stock assessment of Columbia River anadromous salmonids, 2 volumes. Final Report to Bonneville Power Administration, Portland, Oregon (Project 83-335).

Irving, J. S., and T. C. Bjornn. 1981. Status of Snake River fall chinook salmon in relation to the Endangered Species Act. Idaho Cooperative Fishery Research Unit, University of Idaho, Moscow, for U.S. Fish and Wildlife Service.

Jackson, P. L. 1993. Climate. Pages 48-57 *in* P. L. Jackson and A. J. Kimerling (editors). Atlas of the Pacific Northwest. Oregon State University Press, Corvallis.

Johnson, L. 2000. An analysis of support of sediment quality thresholds for polycyclic aromatic hydrocarbons (PAHs) to protect estuarine fish. National Marine Fisheries Service, Seattle, Washington.

Larson, K. W. and C. E. Moehl. 1990. Entrainment of anadromous fish by hopper dredge at the mouth of the Columbia River. Pages 104-112 in C. A. Simenstad (ed.). Effects of dredging on anadromous Pacific coast fishes. Washington Sea Grant. Seattle, Washington.

Lloyd, D. S. 1987. Turbidity as a Water Quality Standard for Salmonid Habitats in Alaska. North American Journal of Fisheries Management 7:34-45.

Lloyd, D. S., J. P. Koenings, and J. D. LaPerriere. 1987. "Effects of Turbidity in Fresh Waters of Alaska." North American Journal of Fisheries Management 7:18-33.

Matthews, G. M. and R. S. Waples. 1991. Status review for Snake River spring and summer chinook salmon. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-F/NWC-200, 75 p.

McClure, M., B. Sanderson, E. Holmes, C. Jordan, P. Kareiva, and P. Levin. 2000a. A standardized quantitative analysis of the risks faced by salmonids in the Columbia River basin. National Marine Fisheries Service, Northwest Fisheries Science Center, Cumulative Risk Initiative, Draft Report, Seattle, Washington.

McClure, B. Sanderson, E. Holmes, C. Jordan, P. Kareiva, and P. Levin. 2000b. Revised Appendix B of standardized quantitative analysis of the risks faced by salmonids in the Columbia River basin. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

McClure, M. M., B. L. Sanderson, E. E. Holmes, and C. E. Jordan. 2000c. A large-scale, multi-species risk assessment: anadromous salmonids in the Columbia River basin. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. Submitted to Ecological Applications.

McElhany, P., M. Ruckelshaus, M. J. Ford, T. Wainwright, and E. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. National Marine Fisheries Service, Northwest Fisheries Science Center, Draft Report, Seattle, Washington.

McGraw, K. A. and D. A. Armstrong. 1990. Fish entrainment by dredges in Grays Harbor, Washington. Pages 113-131 in Effects of dredging on anadromous Pacific coast fishes. C. A. Simenstad, editor. Washington Sea Grant. Seattle, Washington.

McLeay, D. J., G. L. Ennis, I. K. Birtwell, and G. F. Hartman. 1984. "Effects On Arctic Grayling (Thymallus arcticus) of Prolonged Exposure to Yukon Placer Mining Sediment: A Laboratory Study." Canadian Technical Report of Fisheries and Aquatic Sciences 1241.

McMichael, G. A. L. Fritts, and T. N. Pearsons, 1998. Electrofishing In Jury to Stream Salmonids; Injury Assessment at the Sample, Reach, and Stream Scales. North American Journal of Fisheries Management 18:894-904.

Meador, J. P. 1991. The interaction of dissolved organic carbon, pH, and total copper in the determination of ionic copper toxicity. Aquatic Toxicology 19:13-32.

Moore, A. W. and C. P. Waring. 1996. Sublethal effects of the pesticide Diazinon on olfactory function in mature male Atlantic salmon parr. Journal of Fish Biology 48:758-775.

Moore, A. W. and C. P. Waring. 2001. The effects of a synthetic pyrethroid pesticide on some aspects of reproduction in Atlantic salmon (*Salmo salar* L.). Aquatic Toxicology 52:1-12.

Morton, J. W. 1977. Ecological effects of dredging and dredge spoil disposal: a literature review. U.S. Fish and Wildlife Service Technical Paper No. 94.

Mullan, J. W., A. Rockhold, and C. R. Chrisman. 1992a. Life histories and precocity of chinook salmon in the mid-Columbia River. Progressive Fish-Culturist 54:25-28.

Mullan, J. W., K. R. Williams, G. Rhodus, T. W. Hillman, and J. D. McIntyre. 1992b. Production and habitat of salmonids in mid-Columbia River tributary streams. U.S. Fish and Wildlife Service Monograph 1.

Myers, J. M., R. G. Kope, G. J. Bryant, L. J. Lierheimer, R. S. Waples, R. W. Waknitz, T. C. Wainwright, W. S. Grant, K. Neely, and S. T. Lindley. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. National Marine Fisheries Service, Northwest Fisheries Science Center, NOAA Technical Memorandum NMFS-NWFSC-35, Seattle, Washington.

Neff, J. M. 1985. Polycyclic aromatic hydrocarbons. Pages 416-454 *in* G. M. Rand and S. R. Petrocelli (editors). Fundamentals of Aquatic Toxicology. Hemisphere Publishing, Washington, D.C.

Newcombe, C. P., and D. D. MacDonald. 1991. "Effects of Suspended Sediments on Aquatic Ecosystems." North American Journal of Fisheries Management 11: 72-82.

Nightingale, B., and C. Simenstad. 2001. White Paper: Dredging Activities, Marine Issues. University of Washington, Wetland Ecosystem Team, School of Aquatic and Fisheries Science, Seattle, Washington.

NMFS (National Marine Fisheries Service). 1998. Position Document for the Use of Treated Wood in Areas within Oregon Occupied by Endangered Species Act Proposed and Listed Anadromous Fish Species.

NMFS (National Marine Fisheries Service). 1995a. Biological opinion – reinitiation of consultation on 1994-1998 operation of the Federal Columbia River Power System and juvenile transportation program in 1995 and future years. NMFS, Hydro Program, Portland, Oregon.

NMFS (National Marine Fisheries Service). 1995b. Proposed recovery plan for Snake River salmon. NMFS, Protected Resources Division, Portland, Oregon.

NMFS (National Marine Fisheries Service). 1999a. Biological opinion on artificial propagation in the Columbia River basin – incidental take of listed salmon and steelhead from Federal and non-Federal hatchery programs that collect, rear, and release unlisted fish species. NMFS, Endangered Species Act Section 7 consultation. March 29.

NMFS (National Marine Fisheries Service) 1999b. The Habitat Approach: Implementation of Section 7 of the Endangered Species Act for Actions Affecting the Habitat of Pacific Anadromous Salmonids. NMFS, Northwest Regions, guidance memorandum.

NMFS (National Marine Fisheries Service). 2000a. Biological opinion – Reinitiation of Consultation on Operation of the Federal Columbia River Power System, Including the Juvenile Fish Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin (issued December 21, 2000) Hydro Program, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2000b. Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act. Protected Resources Division, NMFS, Portland, Oregon.

NWPPC (Northwest Power Planning Council). 1989. Snake River subbasin salmon and steelhead plan. NWPPC, Portland, Oregon.

ODA (Oregon Department of Administrative Services). 1999. Oregon economic and revenue forecast. Vol. XIX. No. 2. Office of Economic analysis, Salem.

ODFW (Oregon Department of Fish and Wildlife) and WDFW (Washington Department of Fish and Wildlife). 1995. Status report, Columbia River fish runs and fisheries, 1938-94. ODFW, Portland, and WDFW, Olympia.

OPB (Oregon Progress Board). 2000. Oregon State of the Environment Report 2000. OPB, Salem, Oregon.

PFMC (Pacific Fishery Management Council). 1998a. Amendment 8 to coastal pelagic species fishery management plan. PFMC, Portland, Oregon.

PFMC (Pacific Fishery Management Council). 1998b. Final environmental assessment: regulatory review for Amendment 11 to Pacific Coast groundfish fishery management plan. PFMC, Portland, Oregon.

PFMC (Pacific Fishery Management Council). 1999. Amendment 14 to the Pacific Coast Salmon Plan. Appendix A: Description and Identification of Essential Fish Habitat, Adverse Impacts and Recommended Conservation Measures for Salmon. Pacific Fishery Management Council, Portland, Oregon.

Redding, J. M., C. B. Schreck, and F. H. Everest. 1987. "Physiological Effects on Coho Salmon and Steelhead of Exposure to Suspended Solids." Transactions of the American Fisheries Society 116:737-744.

Reisenbichler, R. R., J. D. McIntyre, M. F. Solazzi, and S. W. Landino. 1992. Genetic variation in steelhead of Oregon and northern California. Transactions of the American Fisheries Society 121:158-162.

Scannell, P. O. 1988. Effects of Elevated Sediment Levels from Placer Mining on Survival and Behavior of Immature Arctic Grayling. Alaska Cooperative Fishery Unit, University of Alaska. Unit Contribution 27.

Scholz, N. L., N. K. Truelove, B. L. French, B. A. Berejikian, T. P. Quinn, E. Casillas, and T. K. Collier. 2000. Diazinon disrupts antipredator and homing behaviors in chinook salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 57:1911-1918.

Schreck, C. B. H. W. Li, R. C. Jhort, and C. S. Sharpe. 1986. Stock identification of Columbia River chinook salmon and steelhead trout. Final report to Bonneville Power Administration, Portland, Oregon (Project 83-451).

Servizi, J. A. 1988. Sublethal effects of dredged sediments on juvenile salmon. Pages 57-63 *in* C. A. Simenstad (editor). Effects of dredging on anadromous Pacific coast fishes. Washington Sea Grant Program. Washington State University. Seattle, Washington.

Servizi, J. A., and Martens, D. W. 1991. "Effects of Temperature, Season, and Fish Size on Acute Lethality of Suspended Sediments to Coho Salmon." Canadian Journal of Fisheries and Aquatic Sciences 49:1389-1395.

Sharber, N. G. and S. W. Carothers. 1988. Influence of electrofishing pulse shape on spinal injuries in adult rainbow trout. North American Journal of Fisheries Management 8:117-122.

Sharber, N. G., S. W. Carothers, J. P. Sharber, J. C. DeVos, Jr. and D. A. House. 1994. Reducing electrofishing-induced injury of rainbow trout. North American Journal of Fisheries Management 14:340-346.

Sigler, J. W. 1988. Effects of chronic turbidity on anadromous salmonids: recent studies and assessment techniques perspective. Pages 26-37 in C. A. Simenstad (ed.). Effects of dredging on anadromous Pacific coast fishes. Washington Sea Grant Program. Washington State University. Seattle, Washington.

Sigler, J. W., T. C. Bjornn, and F. H. Everest. 1984. "Effects of Chronic Turbidity on Density and Growth of Steelheads and Coho Salmon." Transactions of the American Fisheries Society 113:142-150. 1984.

Simmons, D. 2000. Excel spreadsheet: Snake River fall chinook, annual adult equivalent exploitation rates (AEQ Catch/[AEQ Catch + Escapement]) adjusted to joint staff estimates of ocean escapement. E-mail. National Marine Fisheries Service, Sustainable Fisheries Division, Seattle, Washington.

Snyder, D. L. 1992 Impacts of Electrofishing on fish. Contribution number 50 of the Larval Fish Laboratory, Colorado State University, Fort Collins.

Spence, B. C., G. A. Lomnicky, R. M. Hughes, and R. P. Novitzki. 1996. An Ecosystem Approach to Salmonid Conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, Oregon. 356 p. Available from the National Marine Fisheries Service, Portland, Oregon.

Stickney, R.R. 1973. Effects of hydraulic dredging on estuarine animals studies. World Dredging Mar. Const.:34-37.

Tabor, J. E. 1976. Inventory of Riparian Habitats and Associated Wildlife Along Columbia and Snake Rivers. Volume River IIB: Lower Columbia River. U.S. Army Corps of Engineers, North Pacific Division.

Tutty, B. D. 1976. Assessment of techniques used to quantify salmon smolt entrainment by a hydraulic suction hopper dredge in the Fraser River estuary. Fisheries and Marine Services. Environment Canada. Technical Report Series No. PAC/T-76-16.

Waring, C. P. and A. Moore. 1997. Sublethal effects of a carbamate pesticide on pheromonal mediated endocrine function in mature male Atlantic salmon (*Salmo salar* L.) parr. Fish Physiology and Biochemistry 17:203-211.

Waples, R.S., R. P. Jones, Jr., B. R. Beckman, and G. A. Swan. 1991. Status review for Snake River fall chinook salmon. U.S. Dept. Commer., NOAA Tech. Memo. NMFS F/NWC-201.

Waples, R. S. 1999. Dispelling some myths about hatcheries. Fisheries 24(2):12-21.

WDF (Washington Department of Fisheries), WDW (Washington Department of Wildlife), and WWTIT (Western Washington Treaty Indian Tribes). 1993. Washington state salmon and steelhead stock inventory (SASSI), 1992. WDF, WDW, and WWTIT, Olympia.

Weitkamp, L. A., T. C. Wainwright, G. J. Bryant, G. B. Milner, D. J. Teel, R. G. Kope, and R. S. Waples. 1995. Status review of coho salmon from Washington, Oregon, and California. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Whitman, R. P., T. P. Quinn and E. L. Brannon. 1982. Influence of suspended volcanic ash on homing behavior of adult chinook salmon. Transactions of the American Fisheries Society 113:142-150.

Whitt, C. R. 1954. The age, growth, and migration of steelhead trout in the Clearwater River, Idaho. Master's thesis. University of Idaho, Moscow.

Zimmerman, M. A. and L. A. Rasmussen. 1981. Juvenile salmonid use of three Columbia River backwater areas proposed for subimpoundment. U.S. Department of Interior, Fish and Wildlife Service, Ecological Services, Portland, Oregon.

Zuranko, D. T., R. W. Griffiths, and N. K. Kaushik. 1997. Biomagnification of polychlorinated biphenyls through a riverine food web. Environmental Toxicological Chemistry 16:1463-1471.